

# CHEMICAL & METALLURGICAL ENGINEERING

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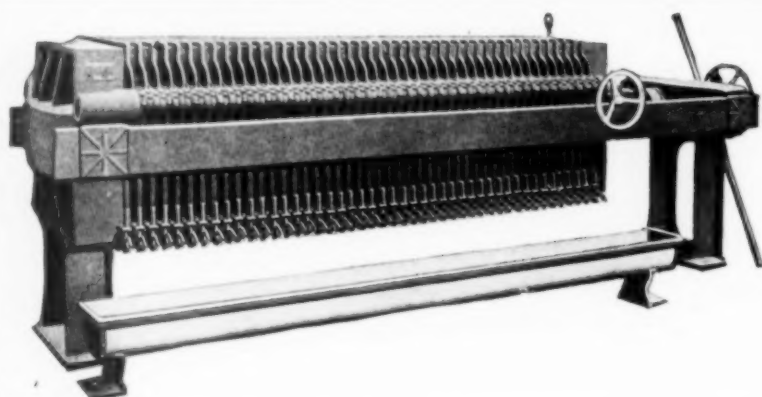
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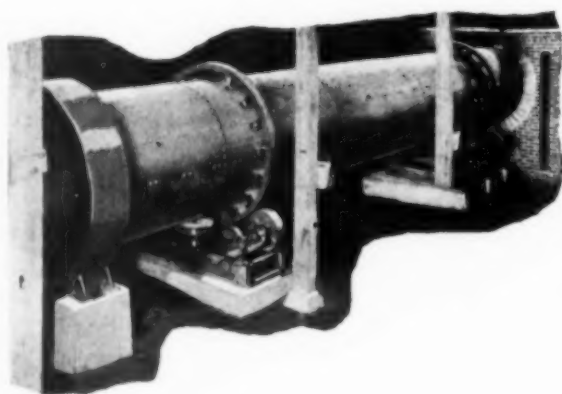
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# CHEMICAL & METALLURGICAL ENGINEERING

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## Let's Go After

### "Two Per Cent for C.W.S."

THE third annual Chemical Warfare Service dinner, which will be held during April, should be the occasion not only for renewal of many friendships but also for vigorous action in the interests of this service. "The gathering of the clan" will give ideal occasion upon which to organize the effort which must be made if chemical warfare is to receive the attention it deserves. And upon that occasion we suggest that some organized effort be started to obtain from Congress "Two Per Cent for C.W.S."

Chemists and engineers in common with other civilized members of the American people desire and will strive for that time when extensive armed preparedness may not be essential. In keeping with this thought it would be difficult to get any large number of chemists who would support the idea of tremendous appropriations for chemical warfare as such. However, chemists and engineers are practical, sensible people rather than idealists and they realize that some military effort is essential without regard to our ideals for international relationships of the future. Moreover, they insist that in this plan must be included a reasonable provision for so essential a branch of the military as chemical warfare. In other words, they can be counted upon to line up unanimously in support of the slogan which we suggest, "Two Per Cent for C.W.S.," that is, provision of approximately 2 per cent of the Army appropriation for this branch of the service.

It takes no argument to convince chemists that gas masks and offensive gas material are as essential to the infantry, the cavalry and the artillery as knapsacks, saddle bags or guns. Without adequate protection against enemy gas attack all of the combatant branches of an army may be helpless. Without gas to shoot against an enemy they are as inadequately equipped as if outfitted with flint locks or popguns. It is only common sense, therefore, to provide a reasonable percentage for chemical warfare out of any appropriation, however large or small it may be in total. And certainly no one can dispute that 2 per cent is unreasonably large, yet this is all that is deemed immediately essential for C.W.S.

In national affairs even more than anywhere else the American people "Let George do it." With respect to the Chemical Warfare Service this policy is no longer safe, for continuation of such plan by the chemists and the chemical industries of the country will inevitably mean a shortsighted inadequate attention to its needs. At the forthcoming dinner we suggest that some official "George" be selected; not one man but a group of men, who will make it a part of their business to sell the big idea of gas defense and offense to those who must be convinced before these military activities will be adequately provided for. If the idea can be sold as it

should be, chemical industries will profit tremendously and the chemists of the country can rest assured that properly planned organized effort of their science will be feasible in case the unfortunate possibility of actual hostilities upon a large scale should again be met by this country.

The researches of chemical warfare are providing much information upon fundamental problems in organic industrial manufacture. Phosgene, chlorpicrin, chloracetic acid and dozens of other important compounds could be named as products of which we will know much more as a result of these studies. Also the theory and the practice of gas absorption and adsorption are being studied in a way that will tremendously interest many other industries. Activated charcoal, the well-known product of chemical warfare investigations, is already proving itself of an industrial value far beyond the total cost of the chemical warfare investigations, and many more such worth while results of this sort of activity can well be expected.

The time for action is at hand, for during the next three months Congress will be called upon to make provision of funds for the Army for next year. Obviously there is no time to delay. Moreover the policy thus fixed for the coming year will be of vital importance for several years to come, since any interruption in the essential research or development program at this stage would double the difficulty and multiply many fold the cost when the work is renewed at a later time. Everyone interested—and what chemist is not so concerned?—must bring his influence to bear immediately.

CHEMICAL & METALLURGICAL ENGINEERING has no hard and fast organization program to suggest. Let the discussion of all those who have been intimately associated in this branch of the service guide in this matter. But as chemists and as industrial men of common sense, let us no longer stand by unorganized in the support of chemical warfare. We have done only a small fraction of what we can and should do. Let us formulate some program which will have as its sole object the fostering for a few years to come of this important idea, "Two Per Cent for C.W.S."

## An Unwise

### Immigration Measure

THE Dillingham immigration bill, which was killed by a pocket veto of President WILSON in the closing days of his administration, is likely to be revived at once by the new Congress. This measure is decidedly unwise. It prescribes an artificial limitation of immigration to 3 per cent a year of the number now in the United States of the same country of birth. Thus, irrespective of anything else, the proportions of foreign born to be admitted are fixed by the numbers now in the United States, as if there were any virtue in the present proportion.

Getting bills through Congress is usually a very practical question, involving the finding of arguments that will go down and of securing enough votes. The argument of assimilability, on which alone a percentage like that of the Dillingham bill can be based, is quite superficial. It assumes in fact that all races are alike in quality of assimilability, the quantity of possible assimilation being this constant factor multiplied by the number of the race now in the country. We say "race," though as a matter of actual fact the Dillingham bill ignores race and refers simply to country of birth.

Several very practical and important objections to the Dillingham immigration measure were presented to President WILSON on March 1 in a brief by the Inter-Racial Council, with headquarters in the Woolworth Building, New York City. These need not be referred to here. Readers of this journal will find their own reasons for opposing such a bill. This country needs labor. It is rich in natural resources and commands much capital that seeks investment if it can secure a proper return. The country has almost unlimited capacity to employ labor. It will be made more prosperous, not less prosperous, by being given a greater supply of labor. The present industrial depression is due largely, not to there having been too much labor, but to there having been too little labor obtainable for a reasonable sum.

A survey of the flow of immigration in the past illustrates the absurdity of the Dillingham limitation to 3 per cent of the number of persons of a given country of birth now in the United States. From period to period the character of our immigration has changed. Long ago there were the Irish, who constituted the "paddies" of a couple of generations ago, and very useful they were. Successively there has been a flow from one country or another, in a sort of rotation. This natural selection resulted in men whose services were least in demand in their native country coming here where work was ready for them. What we want is that work should be done and we should admit those who are most ready to work. Any legislation framed along this line, if additional legislation is necessary, will be welcome.

One naturally asks himself who is back of this move embodied in the Dillingham bill. The accepted view is that it is "the labor interests." That is particularly curious, seeing that organized labor considers itself skilled, while immigrant labor is unskilled. In almost every undertaking there is both skilled and unskilled labor required. The more easily the unskilled part of the work can be done the more room is afforded for the employment of skilled labor. Does the plumber wish to force conditions whereby he will be obliged to dig ditches part of his time, or the bricklayer wish to become his own hod carrier? Apparently labor leaders cannot rid themselves of the fallacious view that there is precisely so much work to be done, that this work will be done, no matter what, and that if the supply of labor is restricted the total paid out for doing this work will be correspondingly increased.

The Dillingham bill, or such other measure along the same line as may be brought forth in the new Congress, should be vigorously opposed. If additional immigration legislation is requisite, a properly thought out plan should be devised. The argument for the Dillingham measure is specious and superficial, while the objections to it are numerous and fundamental.

### A New Gateway To Chemistry

THE address of Dr. IRVING LANGMUIR at the anniversary meeting of the Chemists' Club on March 17 marks a milestone in the history of chemistry. Given a working hypothesis of the structure of atoms, and the path is straightway made clear for chemistry to become a deductive science. Our readers may remember a popular introduction to the consideration of the Langmuir Postulates published in this journal on July 16, 1919. The theory is based on the work of G. N. LEWIS in regard to the so-called cubical atom with that of other savants, co-ordinated and carried on by Dr. LANGMUIR to the state of a working hypothesis. The author makes abundant acknowledgment to the various contributors who have preceded him in the field.

Chemically speaking, the postulates were reasonable, but from the standpoint of physics the objection was raised that the proposed circumscription of electrons to restricted positions was impossible. The theory of BOHR, which has found favor from the standpoint of physics, in which the organization of electrons about a positively charged nucleus might be likened to a solar system, does not aid the chemist. Now Dr. LANGMUIR has succeeded in harmonizing the two theories, so that the developed hypothesis is plausible to the physicist while illuminating to the chemist.

The prospective results of new study with the aid of this enlightenment are amazing. Whereas we have long been engaged in the study of intramolecular phenomena, this opens up the intra-atomic field. It gives us a basis for the computation of the forces emanating from within the atom, so that the perplexing subject of valency may be explained and even valency itself calculated. It offers a reasonable proposal of how each atom is composed, and intimates not only its configuration but even describes the fields of force that surround it within the molecule group. It does not tell how atoms may be broken down, although it may even indicate the way along which such a consummation may be reached—none too soon, let us hope; for we are not good enough to wield such power as yet. But with such a working hypothesis as Dr. LANGMUIR presented, with the structure of each atom agreed upon, with the component forces emanating from every atom in a molecule duly computed, then we should be able to predict the physical qualities of a compound before it is synthesized. It brings within sight the dream of the physical chemist to reason out reactions from start to finish, and then to confirm them by experiment. It gives us the picture of molecules in three dimensions; it tells us of their design, their conformation, and the forces that play from within and about them, the spectral lines of the material product, its colors, its crystal forms, and its reactions.

The time is growing near when, if we are to maintain progress, we must open up this new doorway into the subject, beginning with the study of the reasons why reactions take place, so that with this as familiar information we may compute more and marvel less at the things that are known. And the more we know the greater will be our sense of the unknown infinity beyond us.

Much has already been done along the line of chemical philosophy, but without a definite concept of atomic structures the subject has been difficult, while exposition has been vague. The opening of such a new and illuminating doorway into chemistry will be rather



disturbing to those of us who are of a passing generation, but we are not the persons to be considered.

We have told the story before elsewhere, but it will bear repetition: An assistant of Prof. FRIEDEL in Paris asked him a question in organic chemistry. "Sais pas," answered the professor. "Look it up in Beilstein." After he had been told repeatedly to find in chemical literature answers to the questions that he asked, the assistant inquired of the master whether the instructions were given him for his own benefit, or because the professor did not remember. The old gentleman caught the young man by the arm, led him into the library, and, pointing to the shelves of books there, exclaimed, "Voila! There is all I know. Books are admirable instruments, and we should study them diligently. But why should I encumber my mind with details, making it like a warehouse of unused goods, when all this is available to me? The *general principles*, however, I must always keep alive in my mind!"

That is the way nearly all great chemists understand the subject. It is the true source of enlightenment. It is the way the subject should be taught.

All glory to the few men who, like IRVING LANGMUIR, stand in the watch towers above us, who see the dawn of understanding in these things and point out to us the advancing light!

#### Green Grass as a Mine for Vitamines

VITAMINES have captured the public fancy. There is the Fat-Soluble A which is found in butter fat, and consequently in milk, in cod-liver oil and in green vegetables, which is necessary for the growth of young animals, to prevent (it is believed) rickets in children, and an unpleasant eye trouble called xerophthalmia in many animals, including the human sort. The Water-Soluble B is needed to prevent beri-beri, which follows a prolonged diet which lacks it, and if taken in inadequate quantities we are subject to boils and skin eruptions, such as acne. The ingestion of food containing it acts as a cure, provided the eruptions are due to malnutrition and not to infection. It is found in milk, in fresh vegetables, in the hulls of rice and some other grains, and in yeast. It is believed also to stimulate the activities of certain glands. The Water-Soluble C is anti-scorbutic. Without it we are susceptible to scurvy, and foods containing it constitute the cure. It is also found in milk, in fresh vegetables and in citrus and other fruits. Unlike types A and B it is very susceptible to heat and its keeping qualities are much frailer unless in an acid medium. The subject is discussed more fully by a member of our staff in the current (March) number of *Harper's Magazine*. The molecular structure of these organic bodies is unknown, but it appears that they are rich in nitrogen, they do not contain phosphorus, and tests are developed to demonstrate their presence.

A good rule to assure ourselves of all the vitamines we need has seemed to be to drink a couple of glasses of fresh milk every day and to eat a good plate of salad. But now come along a group of five from the laboratory of the University of Minnesota, R. ADAMS DUTCHER, C. H. ECKLES, C. D. DAHL, S. W. MEAD and O. G. SCHAEFER, who publish in the *Journal of Biological Chemistry* (vol. 45, pp. 119-32, 1920) a note that is perplexing in regard to the amount of milk needed. "A glass or two" was as near as we dared come to prescrib-

ing. But Messrs. DUTCHER et al. tell us of tests that they made with the cows, giving them a vitamine-poor ration in winter, and with the same grains, but also turning them out to pasture, in summer. The green grass, of course, is vitamine-rich. The result was that "20 c.c. of summer milk was superior in nutritive value and anti-scorbutic potency to 60 c.c. of winter milk from the same cows." We knew there was a difference, more particularly in the anti-scorbutic Water-Soluble Vitamine C, between winter milk and summer milk, but this threefold difference was unsuspected.

In view of the growing need of biological chemistry in organic synthesis, we hope that the study of vitamines will find a more cordial welcome as a subject for research, even in industrial laboratories, than it would have found a few years ago. The Water-Soluble B type may be important in a number of protein reactions.

#### The Border Lines Of Colloid Chemistry

COLLOID chemistry has been a domain in itself, governed by its own special laws where legislation had influence and otherwise by hypothetical substitutes. Attempts to subject any considerable part of the colloid state to the laws of general physical chemistry are noteworthy undertakings. Perhaps in a century or two from now, when simplified octet chemistry is taught in the grammar schools, the children will study the history of science as well as of political events and each conquest in chemistry will give the basis for a tale as interesting as the conquests of America by the Spanish chevaliers.

Then Dr. JACQUES LOEB will be famous for annexing the amphoteric proteins to the more civilized chemical dominions of the hydrogen ion, the influence of which will be so well understood by both the young and old octet chemists that all explanatory remarks will be superfluous. Even the name hydrogen will perhaps have succumbed to some compound word, indicating nuclei and electrons, their number and positions.

On the basis of our present chemical status, the colloid chemist may pass off the contribution by Dr. LOEB in this issue with the statement that his observations have been limited to dilute solutions and that Dr. LOEB has only confirmed a common belief that any properly dispersed substance in a proper degree of subdivision will obey the gas laws and the others derived from them.

Arguments pro and con by the advocates of either side will take an indefinite amount of time and will not be settled perhaps until one side dies out, as has happened before in the case of phlogiston, fire-water-earth and so on. This will be a task for the theoretical chemists to fight out among themselves. The technologist will readily see where he comes in and will make use of the hydrogen ion concentrations in solving many of his colloidal problems. The gluemaker will wash his product in solution having the right hydrogen potential to give the isoelectric point where glue is insoluble. The water filtration chemical engineer will also receive guidance from the same source and will operate at the isoelectric point of his amphoteric aluminum hydroxide. Large-scale experiments have recently been undertaken at the city water filtration plant of Toronto, Canada, along this line which are proving that Dr. LOEB is right in practice as well as in theory as far as the factor of the hydrogen ion is concerned.

## Readers' Views and Comments

### The Language of Chemistry

To the Editor of Chemical & Metallurgical Engineering

SIR:—Referring to your editorial in the issue of Feb. 2 on "The Language of Chemistry," permit me to suggest that writers on chemical subjects commonly exercise too little care in expressing their ideas, a fact to which all editors can doubtless attest. Accurate and precise expression when writing on a technical subject cannot be accomplished without the use of technical terms. I am afraid that those who chafe at the use of technical terms are like those who would write *vers libre* or paint Cubist pictures trying to express themselves without having mastered the technique of their art.

The writer sees no possible objection to the correct employment of technical terms. "Pyrolysis" and "pyrolytic," recently suggested by W. A. Hamor, are gems. We need a new word to express the decomposition-of-alcohols-with-the-formation-of-water, improperly termed "dehydration"; we also need quite a number of precise terms to replace expressions crudely translated from the German, such as "splitting off" or "splitting out," also "raw" material.

B. T. B.

New York City.

### British Research on Automobile Steels

To the Editor of Chemical & Metallurgical Engineering

SIR:—Will you pardon me if I point out that an article on the British Steel Research Committee's Report on Automobile Steels in your issue of Dec. 29, 1920, contains a rather serious error in that it describes the 0.35-carbon steel as a case-hardening steel? I think that a reference to the report will show that this steel is not described as a case-hardening steel, and is not intended for such a purpose.

The case-hardening steels used by the committee were much lower in carbon, either with or without nickel, as shown in the following tabulation:

	1H	1L	2H	2L	3H	3L	4H	4L
C.....	0.17	0.06	0.20	0.12	0.15	0.12	0.17	0.07
Si.....	0.24	0.01	0.11	0.05	0.05	0.07	0.39	0.06
Mn.....	0.72	0.25	0.99	0.71	0.61	0.32	0.34	0.18
S.....	0.04	0.01	0.07	0.08	0.02	0.02	0.01	0.02
P.....	0.05	0.05	0.05	0.05	0.01	0.01	0.01	0.01
Ni.....					2.60	2.40	6.00	5.10

BERNARD COLLITT, F. I. C.

Lincoln, England.

### A Question of Therapeutic Value

To the Editor of Chemical & Metallurgical Engineering

SIR:—In your Feb. 16 number is an article "Sulphur Dioxide May Have Therapeutic Value." Shoveling coal may be similarly valuable. During the influenza epidemic of 1918 the working force (over 250) of the American Medical Association was reduced nearly 20 per cent by cases of influenza, but in the engineering department not one of the four men employed there suffered from it. Of course it stands to reason that such evidence is valueless and utterly unscientific if it chlorine, sulphur dioxide or "coal dust."

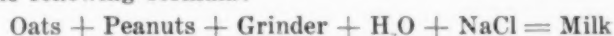
Chicago, Ill.

PAUL NICHOLAS LEECH.

### Bids Bon Jour to Benign Bovine

To the Editor of Chemical & Metallurgical Engineering

SIR:—While Mr. Ford is driving old Dobbin back to the tall uncut the daily press notes that Dr. Earl B. Carr of Melrose, Mass., is likewise herding the gentle cow along the trail toward the never-never land whence the buffalo has disappeared. Through the medium of barnyard chemistry he produces a synthetic milk, using the following formula:



Grind peanuts and oats in sausage grinder, leach with water, add salt and filter. Time required, five minutes.

Can it be that through all these centuries the cow has only been operating as a grinding and leaching plant? If so, the elephants in Central Park, which inhale a great many peanuts daily, may also be made to serve. Are our prize Jerseys and Holsteins to become just family pets along with the Pekinese and poodle? Will the goat which has so long been on the staff of our street-cleaning departments be relegated to the pension list? May we expect a bull movement in September oats and a further scarcity of peanuts in Crackerjack? In other words, and chemically speaking, Mr. Editor, is Dr. Carr's discovery a serious matter? F. GISTON.

### Armour Fertilizer Works

To the Editor of Chemical & Metallurgical Engineering

SIR:—Referring to my articles on the "Armour Fertilizer Plant" which appeared in recent issues of CHEMICAL & METALLURGICAL ENGINEERING, I note that inadvertently I neglected to acknowledge the courtesy of officials of the Armour Fertilizer Works for the information and illustrations used. The writer is deeply indebted to Austin McGlennon, superintendent of works; to Fred C. Lodge, manager in charge of the Armour Fertilizer properties; and to C. H. MacDowell, president of the company, for releasing this information for publication. I note also that I neglected to state that the excellent piece of construction outlined in these articles was carried out under contract with Dwight P. Robinson & Co., Inc., which built both the acid plant and the general construction in the fertilizer plant. The Armour company engineers directed the placing of the mechanical equipment.

CHESTER H. JONES.

Chicago, Ill.

### Investigations of the Chemical Literature

To the Editor of Chemical & Metallurgical Engineering

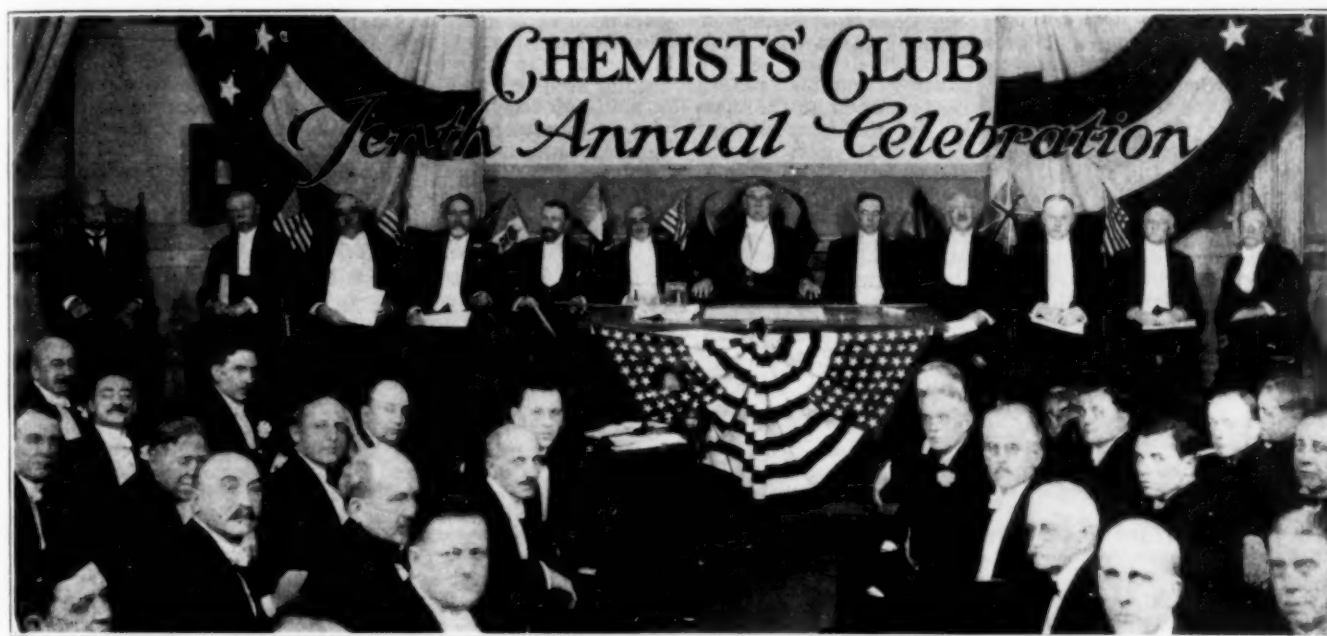
SIR:—May I call your attention to the portion of Mr. Barrows' fine paper on Chemical Literature, headed "Bolton—Select Bibliography of Chemistry" (page 426, CHEMICAL AND METALLURGICAL ENGINEERING, March 9, 1921)?

There is a second supplement to Bolton's Select Bibliography of Chemistry, published by the Smithsonian Institution in 1904. This continues the subject to the close of the year 1902, and contains about 3,500 additional titles.

NATHAN VAN PATTEN.

M. I. T. Library,  
Cambridge, Mass.





**T**HE Chemists' Club celebrated the tenth anniversary of the opening of its clubhouse on Thursday evening, March 17. Eight distinguished chemists were enrolled as honorary members, three of whom were present in person and five by representation. Reading from left to right, those seated on the platform in the photograph heading are:

Professor Emeritus Charles F. Chandler, first president of the club; Dr. Edgar Fahs Smith, Dr. William H. Nichols, his Excellency Rolando Ricci, Ambassador from Italy, representing Giacomo Ciamician; Consul General Gaston Liebert of France, representing Prof. Le Chatelier; Dr. Jacques Loeb, Ellwood Hendrick, president of the Chemists' Club; Dr. Irving Langmuir, Consul General Pierre Mali of Belgium, representing Dr. Ernest Solvay; Counsellor John J. Broderick, of the British Embassy; Dr. Alfred Springer of Cincinnati, representing Dr. John Uri Lloyd; Dr. Edward Weston.

President Ellwood Hendrick predicted that the meeting would take its place permanently among the events in the history of chemistry. Dr. Charles Baskerville, chairman of the committee of arrangements, spoke interestingly of the earlier days of the club and then called upon the several members who presented the honorary members as follows:

#### ERNEST SOLVAY

Presented by Dr. Bernhard C. Hesse

Mr. President, I present Consul General Mali, who stands in the place of Ernest Solvay, founder of the ammonia-soda process, for threescore years a pioneer and leader in industrial chemistry, whose activities have enormously developed the production and use of sodium products over all the world, and likewise have profoundly stimulated dependent and related industries; a leader in the application of scientific study to industrial problems; founder and indefatigable supporter of many institutions devoted to science, to public health and welfare and to the elevation of human intercourse and relations; a source of great strength to his country in her peril, and a shining mark for the vengeance of her despoilers. The members of the Chemists' Club proclaim their admiration and esteem by election to honorary membership.

#### HENRY LOUIS LE CHATELIER

Presented by Dr. Marston T. Bogert

Mr. President, I have the honor to present Consul General Liebert, as representing our ally the Republic of France,

who will receive for Prof. Le Chatelier the honorary membership which we have in mind to confer upon him. Henry Louis Le Chatelier is professor at Collège de France and at L'Ecole des Mines, member of the Academie des Sciences, for over forty-six years an active, resourceful, fruitful, daring and original investigator of the fundamental principles underlying chemical action and thermodynamics. He has enriched our knowledge with countless facts and with many sound and far-reaching theories based upon them; and he has greatly influenced and enhanced the arts of metallurgy, of electrometallurgy, and of applied chemistry generally. He was called on by his country in her time of stress to bring his profound knowledge and experience to bear upon the solution of problems vital to her preservation and necessary to her progress, and on the return of peace he was honored by her with many prizes and medals. To him the members of the Chemists' Club tender evidence of their profound esteem by election to honorary membership.

#### GIACOMO CIAMICIAN

Presented by Maximilian Toch

Mr. President, I have the honor to present his Excellency, Orlando Ricci, Ambassador from Italy, who represents Giacomo Ciamician, Senatore del Regno, professor of general chemistry at the University of Bologna, for more than forty-two years an active, ingenious, fruitful and original investigator in pure organic chemistry, applying it to determine the nature and mechanism of the origin of constituents of plants and animals, and the influence therein of sunlight, uncovering many facts which have finally enabled him so to correlate these phenomena that our view of them has become greatly clarified and much firm ground for further and beneficial advance in this most intricate field has been created. The members of the Chemists' Club elect him to honorary membership in recognition of his eminence in science and in appreciation of an associated ally in a holy cause.

#### SIR EDWARD THORPE

Presented by Dr. Walter S. Landis

Mr. President, I present Sir Edward Thorpe, represented by Counsellor Broderick of the British Embassy. Sir Edward Thorpe was born near Manchester. A student of science at Owens College, the Universities of Heidelberg and Bonn, a brilliant teacher in several colleges in his native land, at the age of three-quarters of a century he is professor of chemistry emeritus of the Imperial College of Science and Technology, South Kensington. For many years director of the Government Laboratories in London, his accuracy of methods of analysis and clarity in their exposition, coupled with a wisdom as to human purposes in the interpretation of law, gave a model for municipal experts in caring for the welfare of his fellow citizens. His delightful biographies of famous chemists are examples of charming literary style for others to study and follow. His Dictionary of Applied Chemistry is an authoritative work, turned to by all seeking full knowledge. His researches in pure chemistry

carried him to the presidency of the Chemical Society of London; his exposition and knowledge of technology were recognized a generation ago by a similar demand on the part of the Society of Chemical Industry, and his breadth of appreciation of all science likewise brought him the vice-presidency of the British Association for the Advancement of Science and the Royal Society. His eminence as a scientist, technologist and author, commanding several languages, for he had a large personal acquaintance with savants of foreign tongues, burdened him with honorary and corresponding memberships in numerous scientific, literary and philosophical academies and societies of other lands. Many times doctored, this Fellow of the Royal Society will long remain a teacher of power, even to many who may never hear his voice. We honor ourselves in electing him to be one of that limited number to whom the Chemists' Club can pay such tribute.

JOHN URI LLOYD

Presented by Victor G. Bloede

(Owing to the serious illness from pneumonia of Dr. Lloyd, he was represented by Dr. Alfred Springer of Cincinnati.)

Dr. John Uri Lloyd was born in New York State. He was a student of science, trained in a severe school of experience in Kentucky. He rose to the professorship of chemistry in the Cincinnati College of Pharmacy and became the president of the American Pharmaceutical Association. By his investigation in phytochemistry, especially applied to medicine, he created new knowledge of alkaloids, glucosides and the physiological variations in reactions of drugs, especially as colloids. A graceful and imaginative pen has augmented his contributions to scientific literature and perpetuated his close and accurate study of the dialect, superstition and folklore of the Blue Grass country. His "String Town on the Pike" alone has aroused interest in chemistry and given pleasure to a world of readers. He, with his brother, has handsomely housed one of the most complete libraries of botany and chemistry in the world, permanently endowed it, and given it in perpetuo to the city wherein he struggled as a youth, conquered as a strong man and now resides, surrounded by the love and esteem of his fellow men. Over threescore years and ten find him still active in the laboratory and public affairs. Numerous honors have come to him and are deservedly his. To them the members of the Chemists' Club take this, their best means, of adding appreciation of his diligent and fruitful labors for human welfare and happiness.

WILLIAM HENRY NICHOLS

Presented by Prof. Wilder D. Bancroft

Mr. President, I have the honor of presenting in person William Henry Nichols, for more than fifty years successfully engaged in those branches of industrial chemistry of fundamental importance to the development of our country, at many places and in every section of this continent; a firm believer in the application of science to industry and always its consistent follower in practice; a staunch and helpful leader and supporter in securely expanding the study of chemical science, research and application in all branches of our educational system; far-sighted in the promotion of international understanding among chemical associations and chemists and for many years with rare patience and discernment creating and fostering opportunities for scientific, technical and social co-operation among the chemists of the United States to the permanent benefit to all. His constructive capacity carried him to the presidency of the American Chemical Society, of which he was one of the founders. His world-wide recognition brought the presidencies of the Society of Chemical Industry and Eighth International Congress of Applied Chemistry. Among the numerous honors and distinctions which have come to him, we, the members of the Chemists' Club, desire to include our appreciation of his great services on behalf of science, business and the welfare of mankind, by electing him to honorary membership.

EDGAR FAHS SMITH

Presented by Dr. Charles L. Reese

Mr. President, I have the honor and take great pleasure in presenting Edgar Fahs Smith, again president of the American Chemical Society after a lapse of twenty-five years; one to whom that Society owes much for devoted and self-forgetful service in its pioneer days; connected with the University of Pennsylvania as educator and administrator for over forty years; a scientist whose researches have covered widely separated fields in electrochemistry, the rare

earths, and atomic weights; author of standard texts on electrochemistry, as well as translator of foreign texts; a historian who adds to a charming literary style the painstaking accuracy and attention to detail which have made him a brilliant teacher and scientist. To the innumerable evidences of esteem and affection on the part of students, colleagues and citizens, we, the members of the Chemists' Club, desire to add ours by his election to honorary membership.

EDWARD WESTON

Presented by Dr. Frederic G. Cottrell

Mr. President, I present Edward Weston, of English birth, for over fifty years an American chemist, physicist and inventor; a scientific investigator of absolute integrity, he has brought to the solution of physical and electrical problems the chemist's point of view. He has been an early worker in the electroplating field, he perfected the dynamo for use in that art; is inventor of the recently rediscovered flaming arc; was one of the pioneers in the development of the incandescent lamp and filament. He is the inventor of standard electrical measuring apparatus. This work involved detailed and long-continued researches on alloys, and the results have led to entirely new views on the nature of metals and non-metals. A wise counsellor in the affairs of the Chemists' Club, the members elect this friend and scientist to honorary membership as an evidence of affection and esteem.

### Chemical and Physical Behavior of Proteins

BY JACQUES LOEB

Life is so completely linked to the chemical and physical properties of proteins that the knowledge of these properties must precede the attempt at unraveling the dynamics of living matter. The modern concepts of colloid chemistry have been used to supply this knowledge, and foremost among these concepts is the idea that the reactions of colloids in general and proteins in particular are not determined by the purely chemical forces of primary valency, but by the rules of adsorption; and that the influence of electrolytes on the physical properties of proteins is due to an alteration in the degree of dispersion or in the degree of hydration of the protein particles. The speaker has reached the conclusion that these views are based on a methodical error, so far as the proteins are concerned—namely, on the failure to take into consideration the hydrogen ion concentration, which happens to be the chief variable in the chemistry and physical chemistry of proteins. When this variable is duly considered, it is found that the laws of classical chemistry account for both the chemical and the physical behavior of the proteins.

#### ISOELECTRIC POINT

Proteins are amphoteric electrolytes the chemical behavior of which depends on the hydrogen ion concentration of the solution. When the hydrogen ion concentration exceeds a certain critical value—which is termed the isoelectric point of the protein—the protein can combine only with anions, forming salts of the type of gelatine chloride, sulphate, etc., according to the nature of the acid added. When the hydrogen ion concentration is below this critical point, the protein can form metal proteinates—e.g., Na gelatinate, Ca gelatinate, etc. At its isoelectric point, a protein can combine with neither anion nor cation. The natural method of freeing a protein from ionogenic impurities consists, therefore, in bringing the protein in powdered form to its isoelectric point and washing it with cold water.

#### STOICHIOMETRICAL RELATIONSHIPS

The proof that the proteins combine by the purely chemical forces of primary valency and in strictly



stoichiometrical proportions with acids and alkalis is furnished by the titration curves. If we add different acids to an isoelectric protein, we notice that in order to bring a protein solution to a definite  $p_H$ —e.g., 3.0 or 2.5—exactly three times as many c.c. are required of N/10  $H_2PO_4$  as of N/10 HCl or N/10  $HNO_3$ ; while equal numbers of c.c. of N/10  $H_2SO_4$  and of HCl are required for this purpose. When we titrate with alkali, we find that exactly as many c.c. of N/10  $Ca(OH)_2$  or of  $Ba(OH)_2$  are required as of N/10 NaOH or KOH. These and many similar experiments leave no doubt that acids and alkalis combine with proteins according to the purely chemical forces of primary valency. The proof has been furnished not only for gelatine but also for crystalline egg albumin and for casein.

It follows from these experiments that the anions of weak dibasic or tribasic acids combine with proteins in the form of monovalent ions. Thus the anion of gelatine phosphate is the monovalent anion  $H_2PO_4$ , and not the trivalent anion  $PO_4$ ; while in the case of gelatine sulphate the anion is the divalent  $SO_4$  ion.

#### PROPERTIES A FUNCTION OF HYDROGEN ION CONCENTRATION

These facts furnish the clue for the understanding of the influence of ions on the physical properties of proteins. Before these experiments were made it was customary to express the effect of ions on the physical

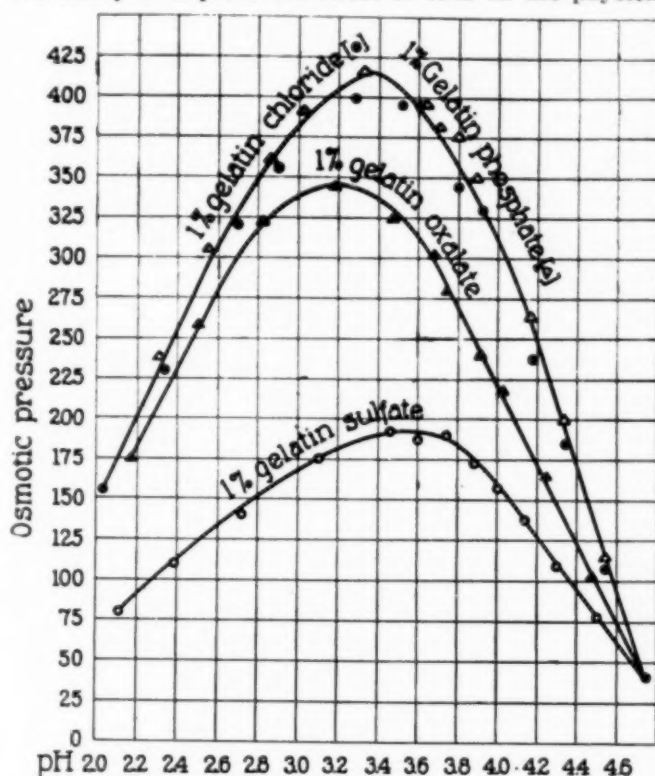


FIG. 1. OBSERVED VARIATION OF OSMOTIC PRESSURE WITH HYDROGEN ION CONCENTRATION

properties of proteins in terms of the so-called Hofmeister series. I have been able to show that these series are based on an error due to the fact that the influence of the variation in the hydrogen ion concentration was overlooked and erroneously interpreted as being the expression of a specific influence of the anion of the acid. If the effect of different ions is compared at the same hydrogen ion concentration, it is found that only the valency of the ion with which the protein is in combination influences the properties of a protein;

while the nature of the ion is of no significance. Thus gelatine chloride, nitrate, tartrate, succinate, citrate and phosphate have the same osmotic pressure, the same viscosity, the same amount of swelling (at the same hydrogen ion concentration and the same concentration of originally isoelectric gelatine), for the reason that in all these cases the anion with which the protein is in combination is monovalent. The osmotic pressure, swelling and viscosity of gelatine sulphate are, however, considerably lower than those of gelatine chloride of the same  $p_H$  and the same concentration of gelatine, for the reason that the  $SO_4$  ion in combination with the gelatine is bivalent.

The fact that only the valency of an ion influences the physical properties of a protein, while the nature of the ion is of no significance (unless it causes a constitutional change in the protein molecule), is the crucial point in the interpretation of the influence of ions on the physical properties of proteins; since this fact suggests that this influence depends on simple equilibrium conditions and not on a change in the protein, such as hydration or degree of dispersion.

When increasing quantities of the same acid are added to isoelectric protein—e.g., a 1 per cent solution of isoelectric gelatine—the values for osmotic pressure, swelling, viscosity, first increase until a maximum is reached (at a  $p_H$  varying for the three properties between 3.6 and 3.0) and drop again with a further increase in acid added. Colloid chemistry explains such variations on the basis of variations in the degree of aggregation of the particles or of variations in the degree of hydration of the protein particles. When a neutral salt is added to a protein solution, the osmotic pressure, swelling and viscosity drop, and this is also ascribed to a depression in the degree of dispersion or hydration of the protein particles.

#### THE DONNAN EQUILIBRIUM

Recent investigations have led me to a different view—namely, that the influence of valency, hydrogen ion concentration and the addition of salt on the physical properties of proteins find their explanation in a field entirely foreign to colloid chemistry—namely, to a peculiar equilibrium condition the theory of which was worked out by Donnan. Donnan<sup>1</sup> has shown that when we separate two salt solutions by a membrane which is impermeable for one of the ions while permeable for all the rest, a peculiar equilibrium results at which the distribution of the ions on the opposite sides of the membrane is unequal. It is immaterial whether the ion which cannot diffuse through the membrane is a colloid or a crystalloid. Procter<sup>2</sup> made use of this Donnan equilibrium to prove that the swelling of solid gelatine chloride is an osmotic phenomenon which can be explained quantitatively on the basis of the Donnan equilibrium.

I started in my investigations with a measurement of the potential differences which exist between a 1 per cent gelatine chloride solution contained in a collodion bag and the surrounding water after osmotic equilibrium is established (e.g., after eighteen hours). It was found that the influence of the hydrogen ion concentration, the valency of the anion in combination with the gelatine and the addition of neutral salt on the

<sup>1</sup>Donnan, F. G., *Z. Elektrochem.*, 1911, vol. 17, p. 572. Donnan, F. G., and Harris, A. B., *J. Chem. Soc.*, 1911, vol. 99, p. 1554. Donnan, F. G., and Garner, W. E., *J. Chem. Soc.*, 1919, vol. 115, p. 1313.

<sup>2</sup>Procter, H. R., *J. Chem. Soc.*, 1914, vol. 105, p. 313. Procter, H. R., and Wilson, J. A., *J. Chem. Soc.*, 1916, vol. 199, p. 397.

TABLE I.  $pH$  OF INSIDE AND OUTSIDE SOLUTIONS AT EQUILIBRIUM (AFTER 18 HOURS)

	Concentration of $NaNO_3$									
	M/	M/	M/	M/	M/	M/	M/	M/	M/	M/
$pH$ inside.....	0	4096	2048	1024	512	256	128	64	32	
$pH$ outside.....	3.58	3.56	3.51	3.46	3.41	3.36	3.32	3.29	3.25	
$pH$ inside minus $pH$ outside.....	0.53	0.48	0.41	0.35	0.27	0.19	0.12	0.07	0.01	

Original inside solution, 1 per cent originally isoelectric gelatine dissolved in various concentrations of  $NaNO_3$  made up with HCl to  $pH$  3.5.

Outside solution, same concentrations of  $NaNO_3$  all made up with HCl to  $pH$  3.0.

TABLE II. POTENTIAL DIFFERENCE BETWEEN GELATINE SOLUTION AND OUTSIDE SOLUTION

Concentration of $NaNO_3$	Calculated by Nernst's Formula from $pH$ , Table I Millivolts	Observed Millivolts
0	31.2	31
M/4092	28.3	28
M/2048	24.0	24
M/1024	20.7	22
M/512	16.0	16
M/256	11.2	12
M/128	7.0	7
M/64	4.1	4
M/32	0	0

P.D. was similar to the influence of the three factors on the osmotic pressure, the swelling, and the viscosity of proteins. This in itself would have meant little more than that a fourth property of proteins had been found which varies like the other three properties mentioned, if it had not been for the fact that it was possible to correlate the variations of the P.D. quantitatively with the Donnan equilibrium.

When a gelatine chloride solution is separated from pure water by a collodion membrane, free HCl diffuses into the water, and when equilibrium is established, the concentration of acid in the water (the "outside solution") is greater than in the gelatine solution (the inside solution). This was observed by Procter for blocks of gelatine chloride surrounded by water, and by the speaker when a solution of gelatine chloride was separated from water by a collodion membrane. Procter has shown that on the basis of Donnan's theory the equilibrium is defined by the equation  $x^2 = y(y+z)$ , where  $x$  is the concentration of the H and Cl ions in the outside solution,  $y$  the concentration of the H and Cl ions of the free acid in the gelatine (inside) solution, and  $z$  the number of Cl ions in combination with gelatine.

If we write the equation in the form

$$\frac{y}{x} = \frac{x}{y+z}$$

$\frac{y}{x}$  becomes the ratio of the concentration of the hydrogen ions inside over those outside. If we assume that the P.D. measured in our experiments was due to the difference in the hydrogen ion concentration on the opposite sides of the membrane, then it would follow from Nernst's well-known logarithmic formula that the

P.D. should be equal to  $0.058 \log \frac{y}{x}$ . Log  $y$  is, however, the  $pH$  of the inside solution and  $\log x$  is the  $pH$  of the outside solution. Hence, if the Donnan equilibrium

was responsible for the P.D., the observed P.D. should be equal  $0.058 (pH \text{ inside minus } pH \text{ outside})$ .

#### CALCULATED AND OBSERVED POTENTIAL DIFFERENCES

It was found that the values for the P.D. calculated on this assumption were in good agreement with the observed values. This left no doubt that the influence of the valency, of the hydrogen ion concentration and of the addition of neutral salt on the variation of the P.D. found its complete qualitative and quantitative explanation on the basis of the Donnan equilibrium.

The close analogy between the influence of  $pH$ , valency and neutral salt on the P.D., and on osmotic pressure and swelling, suggested the possibility that these latter properties might also be determined by the Donnan equilibrium. I have calculated on the basis of the Donnan theory the influence of the valency of the anion and of the  $pH$  on the osmotic pressure of 1 per cent solutions of gelatine phosphate, chloride and sulphate, and albumin chloride and sulphate, and find the

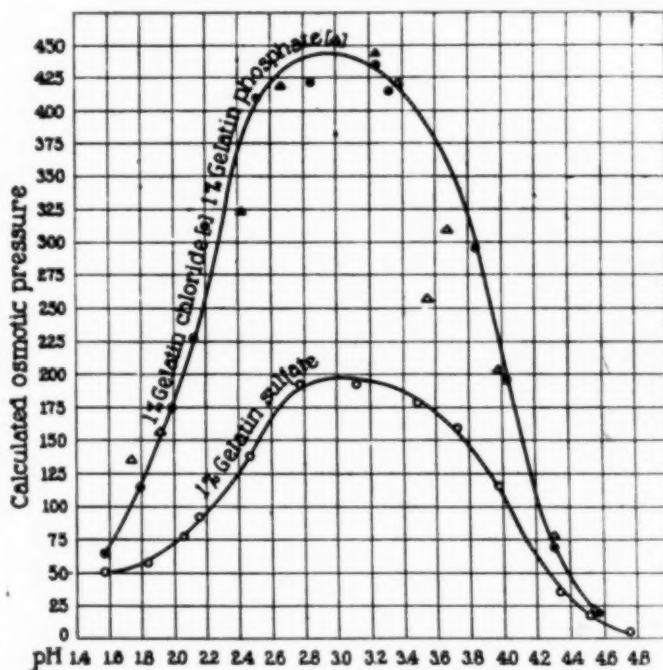


FIG. 2. CALCULATED VARIATION OF OSMOTIC PRESSURE WITH HYDROGEN ION CONCENTRATION

calculated values agree with the observed osmotic pressures not only qualitatively but practically quantitatively. Thus the curves of the observed osmotic pressure of gelatine chloride and gelatine phosphate (Fig. 1) when plotted over the  $pH$  as abscissæ are practically identical and so are the curves calculated on the basis of Donnan's theory (Fig. 2); and, what is more, the calculated and observed curves are, except for two minor variations, practically identical. Furthermore, the observed osmotic pressures for gelatine sulphate are not quite one-half of the observed pressures for gelatine chloride (of the same  $pH$  and concentration of originally isoelectric gelatine, Fig. 1). The same

TABLE III. INFLUENCE OF THE HYDROGEN ION CONCENTRATION ON  $pH$  INSIDE MINUS  $pH$  OUTSIDE AND ON P. D. OF GELATINE-CHLORIDE SOLUTION AT EQUILIBRIUM

	C.c. of N/10 HCl added to 100 c.c. 1 per cent isoelectric gelatine									
	1	2	4	6	8	10	12.5	15	20	30
$pH$ inside.....	4.56	4.31	4.03	3.85	3.53	3.25	2.85	2.52	2.13	1.99
$pH$ outside.....	4.14	3.78	3.44	3.26	2.87	2.81	2.53	2.28	2.00	1.89
$pH$ inside minus $pH$ outside.....	0.42	0.53	0.59	0.59	0.46	0.44	0.32	0.24	0.13	0.10
P. D. calculated, m.v.....	+24.7	+31.0	+34.5	+34.5	+27.0	+25.8	+18.8	+14.0	+7.6	+5.9
P. D. observed, m.v.....	+24.0	+32.0	+33.0	+32.5	+26.0	+24.5	+16.5	+11.2	+6.4	+4.8



difference exists between the calculated osmotic pressures for gelatine chloride and gelatine sulphate (Fig. 2).

Nothing brings out more clearly the difference between the viewpoint of colloid chemistry and the viewpoint of classical physical chemistry than this latter result. In the literature of colloid chemistry  $\text{SO}_4$  is called a dehydrating ion which is supposed to diminish the swelling and the osmotic pressure of proteins through a modification of the protein. From our viewpoint the apparent dehydrating effect of  $\text{SO}_4$  is merely the consequence of the fact that the valency of the ion with which the protein is in combination modifies the relative distribution of the crystalloidal ions on the two sides of the membrane.

The fact that the Donnan equilibrium is the basis of the variation in osmotic pressure explains also why only the valency and not the nature of the ion has any influence on the osmotic pressure, since the equilibrium equation is the same for all protein-acid salts with monovalent anion. The nature of the anion does not enter into the equilibrium equation.

#### QUANTITATIVE THEORY IN DEVELOPMENT

If we summarize all these results, we may say that the experiments based on the measurement of the hydrogen ion concentration have proved that the proteins combine with acids and alkalis according to the purely chemical forces of primary valency and in the same stoichiometrical relations in which acids and alkalis combine with crystalloids. They have led to the result that only the valency but not the nature of the ion in combination with a protein affects such physical properties as the P.D. and osmotic pressure and they have further led to the result that this fact finds its explanation in the Donnan membrane equilibrium. Moreover, it was possible to show that the influence of the hydrogen ion concentration on the P.D. and on the osmotic pressure of protein solutions can also be accounted for not only qualitatively but almost quantitatively by Donnan's theory of membrane equilibrium. Procter's experiments and some of the writer's experiments which are not yet complete suggest that the influence of the hydrogen ion concentration and of the valency of the anion on the swelling of gelatine-acid salts may possibly be explained in the same way. The classical laws of general and physical chemistry therefore furnish us with a quantitative theory not only of the chemical behavior of proteins but also of at least some of the physical properties.

#### Future Developments of Theoretical Chemistry

BY IRVING LANGMUIR

During these ten years that the Chemists' Club has been in this building, of course every chemist knows that great changes have taken place in his science. These are not only changes brought about by the great war, resulting in the stimulation of the chemical industries, but the theoretical work that has been done in chemistry and physics during these years has already had an important influence on theoretical chemistry, and will have an increasing effect as time goes on.

When we look back over the development of science and realize what important applications are made, for example, of the work of Faraday, in electrochemistry, and of Faraday and Maxwell in electrical engineering, and consider that the same kind of thing has happened

already in some fields of chemistry and must happen repeatedly in the future, we have to value very highly the purely scientific pioneer work.

#### CONCEPTION OF THE ATOM FROM THE ELECTRON ASPECT

During the last ten years a new viewpoint regarding chemical phenomena has been developed. This is the outgrowth of the work of Sir J. J. Thomson and his school. The discovery of the electron occurred only a little over twenty years ago. Up to ten years ago its applications were limited mainly to physical problems, discharges through vacua, conductivity through gases, radioactivity, X-rays, and so on. But beginning about 1911 this began to have deep significance to the chemists, because it gave definite knowledge of the constitution of the atom; and the atom, after all, to the chemist is the most fundamental thing that he has to deal with. If he understood the atom, knew how it is built and is held together, his science then would become a deductive science, it would become like mathematical physics, where from fundamental principles and rigorous reasoning the results of numberless experiments can be predicted with high precision.

#### THE NUCLEAR ATOM OF RUTHERFORD AND BOHR

About 1911 Rutherford proposed the theory of the nuclear atom, viz., that the atom has a nucleus of positive electricity at its center, and that the electrons are arranged in space about the nucleus.

In 1913 Bohr gave this theory a very definite form, a form which has been extremely valuable and stimulating, by assuming that these electrons are rotating in circular or in elliptical orbits about the nucleus. He also brought in a new element into the theory of atomic structure, the quantum idea, which was derived from the theory that Planck developed in 1903. That is, Bohr assumed that the energy of motion of electrons is determined not only by the ordinary laws of motion, such as Kepler's laws (like planets moving around the sun), but also by a condition which we call a quantum condition, that the angular momentum of the electron about a nucleus shall be a certain multiple of a definite unit. Thus, of all possible orbits consistent with the ordinary laws of orbital motion, only those must be selected which fulfill also these quantum conditions, so that instead of having an infinite number of possible orbits, you have a definite or discrete number of orbits. This quantum theory greatly simplifies the problem, makes it definite, whereas otherwise it would be indefinite.

Now this idea of Bohr has proved of extreme value. For the case of the hydrogen atom he has given us a picture which has been satisfactory quantitatively, that is, it gives us precisely, with an accuracy something like one part in two hundred thousand, nearly all the lines in the spectrum of atomic hydrogen. It has predicted new lines of helium, showing that certain lines which were thought to be lines of hydrogen were really lines of helium. It has shown that these new lines of helium should be slightly displaced from the positions of certain lines of hydrogen, and shown that this displacement is accounted for quantitatively as the effect of the difference in the atomic weight of helium and hydrogen. The theory in its later forms has also shown that these lines, which at first were thought to be simple lines, really have a finer structure; that is, with higher resolving power they can be shown to consist of two or three lines, and the displacement of those

lines from one another is given exactly by this theory. Such remarkable results certainly indicate that we are on the right track in dealing with spectral problems from the quantum point of view.

Then besides this work of Bohr we must consider the work of van den Broek and Moseley, who developed the idea of atomic numbers, that the number of charges on the nucleus is the same as the ordinal number of the element in the periodic table, giving us a clear picture of what the periodic table means from the chemical point of view. Of equal importance to the chemist is the work of Bragg on the structure of crystal by the X-ray method, which has given us definite knowledge of the arrangement of atoms in crystals, which in turn has revolutionized our ideas of valence, showing that in sodium chloride each chlorine is surrounded by six sodiums, and each sodium by six chlorines; that there are no molecules in sodium chloride crystals in the ordinary sense. All those things have come within the last ten years.

#### DEDUCTIVE CHEMISTRY

And these things mark the beginning, I believe, of a new chemistry, a deductive chemistry, one in which we can reason out chemical relationships without falling back on chemical intuitions. Chemical science in the past has been in a way like biology, botany, geology and so on, in which we deal with general relationships, where we cannot express results quantitatively. We have had, of course, certain fundamental quantitative laws, thermodynamic laws, laws of combining multiple proportions, for example; but although these have been of great importance, they have been capable of accounting for only an insignificant proportion of chemical phenomena.

Now, if we look ahead what do we see as the most probable development in purely theoretical chemistry during the next few years? I believe the field of atomic structure will dominate theoretical chemistry, because a knowledge of atomic structure will enable us to deduce the chemical and physical properties of atoms and molecules.

I have spoken of chemical intuition. The organic chemist of experience knows what the properties of a compound that he has not yet made are likely to be. He has an idea what the color of a certain dye is going to be before he makes it. He tries to make a dye of a certain color. He tries to make a substance which will have certain medicinal properties, and very often succeeds.

Now it is almost impossible to explain the methods by which those results are arrived at, for example, to a physicist. They are not exactly deductive methods; they are more or less intuitive methods, based on large experience, experience which cannot be summarized in a few words, but results in a kind of feeling, a "hunch," that certain results will follow. Now the chemist has accomplished wonders by just that kind of method. Those outside of the field of chemistry do not sufficiently appreciate the value of this method. For instance, the physicist usually does not have much faith in theories of valence. He sees that there are varying values given for valence, and he does not see how reliable predictions of the properties of new compounds can be made on such a basis. But the chemist values those more or less indefinite ideas more highly, and knows how to discount them where needed. He knows that he must not always take the valence of

nitrogen as 3; he must use his judgment in interpreting and making his predictions.

Now the question arises, can this chemical intuition be supplemented by anything which is more powerful? Can we derive with much more precision and certainty, what the properties of compounds are going to be before they are made? Can we tell why it is that the compounds that we have already discovered are the only ones that we have observed; why they are the stable ones, why other compounds whose formulas you might write down on paper are not so stable?

#### THEORY OF VALENCE SUPPLEMENTED

Within the last month or so I have been trying to analyze the theory of valence, which was developed a few years ago by G. N. Lewis and myself; I have been attempting to analyze that theory more from the point of view of the physicist. In attempting to explain the theory of valence, deriving it from conceptions of atomic structure, I have found physicists extremely skeptical as to the possibility of predicting the properties of compounds. I have not found that difficulty with chemists at all, but the physicist has convinced me that there is a real difficulty there which he experiences because he has not the chemical intuition to help him along. He wants the whole story, not just the part of it which will supplement our ordinary chemical knowledge. That is, he will not grant any ordinary chemical knowledge, he wants the basis for all of it. And the viewpoint is an extremely valuable one, and I think is one which we must lay more stress on in the future, if we want to make chemistry a deductive science.

As an example of what I mean, from the theory of valence which I call the octet theory you can calculate by counting up the number of electrons in an atom (which we know very definitely in every case) how many pairs of electrons could be held in common between the atoms in a molecule. Now, G. N. Lewis has shown that each pair of electrons in common is what the chemist has called in the past a chemical bond.

Since you can count up the number of such electrons, you can say that there cannot be more than a certain number of bonds, or in some cases you may say that there cannot be less than a certain number of bonds. There must be a certain number of bonds in the molecule, but that theory does not tell you yet where those bonds must be. For example, if you try to apply the theory to a compound consisting, say, of four chlorine atoms and one carbon atom, your theory tells you there must be four bonds, but it does not say where. Now, to a chemist you do not have any difficulty in saying that you put the carbon atom in the middle and the four chlorines around, and that gives you carbon tetrachloride and that satisfies the chemist and looks simple enough; but the physicist says, why put the carbon atom in the middle? Why not put one of the chlorines in the middle and the carbon off to one side? You see, that is a very important question from the physicist's point of view. If you are not going to assume any chemical knowledge whatever, why should you not put the chlorine in the middle and have the carbon off all by itself on one side, held by one bond?

Well, the chemist says of course the carbon has a valence of 4. But why should it have a valence of 4? So I have been trying to find out what new points of view we want to bring in, in order to make the octet theory of valence much more definite, and to be able to



predict that the carbon must be in the middle and the chlorines around it, when the four bonds are to be placed among those five atoms.

And I found that to do that, all you need is to call upon Coulomb's law, which is simply the law of inverse square attraction and repulsion between positive and negative charges. From that simple, well known law you can supplement the theory of valence to a degree which seems to me to almost eliminate the necessity for chemical intuition in regard to determining what compounds will be stable and which ones will not be stable. You can then readily derive mathematical formulas to calculate the energy of a given molecule. The potential energy of the electrons with respect to the nuclei and of the electrons with respect to each other can be calculated on the basis of any geometrical model. This potential energy determines how much energy it will take to pull those particles apart, and determines the relative stabilities of different kinds of molecules. I believe, although I have not yet made many quantitative calculations, that on the basis of a very few reasonable assumptions regarding the dimension of the models of molecules, we will be able to calculate with considerable precision the heats of reaction of various chemical substances. Qualitatively, as far as I have worked the thing through, you can consider enormous numbers of substances, and figure out immediately which ones will be the most stable. As far as I can see there is a general close agreement, based on the simple conception that the most stable structure is the one in which the total potential energy is a minimum.

Another way of stating that result is simply this, that the most stable arrangement is that in which there is the most uniform distribution of positive and negative particles. The reason that carbon tetrachloride does not have a chlorine atom in the middle and a carbon off to one side is that that would not be anywhere near as uniform a distribution of positive and negative electricity. If you figure out the potential energy it comes out that way. It is nearly as uniform a distribution as one in which the carbon is placed in the centre. You can very readily put this theory in a simple quantitative form suitable for convenient application.

#### PREDICTING PROPERTIES OF CHEMICAL MOLECULES

A few months ago I had occasion to talk before a body of physicists on the subject of atomic structure, and was discussing this possibility of predicting the properties of chemical substances without definite chemical knowledge, on the basis simply of certain fundamental principles regarding the stability of certain groupings of electrons. From the position of the inert gases in the periodic table, we can take it as a fact that two electrons around the nucleus as in the helium atom, for example, give a very great stability.

Now, accepting that as a fact, the question was what can be deduced from it. I found a good deal of skepticism among these physicists as to what really could be done from such simple assumptions, until finally I proposed to one of the members who was most active in the discussion or criticism of the theory—in a constructive way, however—that he should answer the question himself as to what a physicist could deduce in regard to the properties; I therefore asked him what compounds there would be between hydrogen and lithium, and if he could tell me what the properties of that substance would be, if there is such a substance. He replied that he had no knowledge of any compounds of

lithium and hydrogen; but by applying the fundamental idea that a pair of electrons around a nucleus will form a very stable configuration, and also by using his knowledge of Coulomb's law and other well known electrical laws he was able in a very few minutes to derive these conclusions: That lithium hydride should have a formula  $\text{LiH}$ ; that it should be a white crystalline solid body under ordinary conditions, a non-conductor of electricity when solid, but if molten should conduct electricity electrolytically, and hydrogen should appear at the anode, which is not where hydrogen usually appears. Now many of the properties of lithium hydride were not known until recently; but G. N. Lewis predicted those facts in regard to the electrolytic conductivity of lithium hydride, and only recently, within six months or so, Prof. Nernst has had published an article on electrolytic conductivity of lithium hydride, showing that the hydrogen is liberated at the anode instead of at the cathode. Those were predicted in this case by a physicist who had never heard of lithium hydride, and doubted very much whether such a thing existed.

#### FUTURE CHEMICAL EDUCATION

Now I give this illustration to emphasize a point which I believe it is necessary to consider in a discussion of the future development of science, particularly chemistry. As a science like chemistry progresses it becomes more and more complex. We learn more and more facts. We cannot expect every student of chemistry to go through the whole historical development of chemistry and learn all the facts that we have had to learn. The student who is to study chemistry twenty years from now will need to spend much of his time learning the facts that will be discovered during these next twenty years and will not have nearly as much time as we have to study the discoveries of the last 100 years. To cover the ground he will need to be able to deduce a large part of what we now know from a few simple and almost obvious principles unknown to us.

At the meeting of the body of physicists that I referred to a short time ago there was a discussion as to how chemistry should be taught, and it was maintained by one professor of chemistry that the atomic theory should be taught only after all the general chemical facts are known; that is the teaching of chemistry should follow the historical sequence but with Dalton left out. The students should have all the knowledge that chemists had when they got their ideas of atomic structure, in order that the students may realize how useful the theory is as a method of summarizing the results of experiment.

Now it seems to me that is fundamentally wrong. What we must do now is to present to the student just enough knowledge for him to understand and realize the experimental basis for our ideas of atomic structure, and then use that knowledge of atomic structure in order to deduce practically all the knowledge that most of us have on chemical facts. I think that within a few years we will be able to deduce 90 per cent of everything that is in every text book on chemistry, deduce it as you need it, from simple ordinary principles, knowing definite facts in regard to the structure of the atom. If you know your atoms you will know how they will behave when you put them together. Now if you do that, you can cut down the amount of effort on the part of the student to such a point that he can then go ahead and learn the facts that are going to be discovered in the next twenty years, and will not have to

spend his whole course of instruction in learning what we have had to learn.

It seems to me that we must realize that as each science progresses it gets more complex in some ways, but it also gets more simple in other ways, so that you get broader principles, which allow you to correlate great numbers of facts and put them into simple form.

#### DIFFERENCES IN BOHR'S AND LEWIS'S THEORIES NOT IMPORTANT

How can those things which we know by experience or by a long process of education be made to appear obvious to the future student, on the basis of certain things that he knows about the atoms? Of course, to go as far as we should like in that direction we will need to know a great deal more about the atom than we do now, for there are some serious difficulties at present. G. N. Lewis in 1916 gave us a picture of atoms with the electrons stationary, held in equilibrium in some unknown way. This is quite opposed to Bohr's theory, in which the electrons are rotating about the nucleus, held out by centrifugal force.

Now from a chemical point of view it really makes very little difference whether you have one or the other. It is a matter that is not of vital importance. You can get a large part of what I have been speaking of, general relationships, by merely considering certain broad geometrical factors, such as the arrangements of electrons in a form having cubic symmetry as distinguished from one with tetrahedral symmetry. This distinction does not depend on any knowledge of whether the electrons are in motion or are at rest. All the chemist usually needs to know is how many electrons are there, and how many are held in common between two atoms. Well, they can be held in common possibly by being stationary between them, or they can be held in common by rotating in a circle between the two atoms. It makes no difference to the chemist when dealing with general relationships.

#### CALCULATIONS OF QUANTITATIVE DATA

But when we want to go further than general relationships, when we want to get quantitative data, when we want to tie down our chemical facts to observations on spectra, if we want to make use of every spectral line—and there are thousands and thousands of lines in the spectrum of iron—if we want to make use of every one of those lines, in order to predict with precision what the properties of the iron atoms are, we have to know quantitatively what the electrons are doing, and therein I think lies the great future in chemistry. Find the laws of attraction and repulsion and motion of the electrons in atoms, as Bohr has done it for the hydrogen atom, and then from the knowledge of those forces be able to predict or calculate the heat of reaction of a substance with the same kind of accuracy.

Now, of course, to begin with we will be quite content with accuracy within 10 per cent; then later within 1 per cent; but I think that the future holds out for us the possibility of being able to predict heats of reaction, densities, all physical and chemical properties of substances, more accurately than we can determine them by direct methods. I think that is coming, and not so very far off. Already in Germany, Born and Landé have calculated the compressibility of the alkali halides from atomic structural data. They have calculated the heats of reactions; they have predicted on the basis of atomic structure what the energy would be, the heat of

reaction in other words, when an electron combines with a chlorine atom; and they struck it right within a few per cent. It was determined experimentally by Foote and Mohler a year later, and the prediction was verified.

Now, when you can predict heats of reaction, vast possibilities are opened up to the chemist. Thus by deductive means, possibly from the spectra of the elements or from certain fundamental facts in regard to the atomic structure, we may be able to get very much further than we can by ordinary experimental methods.

#### ORBITAL MOTION CAN PROVISIONALLY BE NEGLECTED

The fundamental question in my mind is whether these electrons are moving or are relatively stationary. The evidence of Bohr's theory has seemed to be almost overwhelming that they are moving in orbits. If this is the case the calculation of the properties of substances seems fundamentally extremely complicated, for the astronomer has never been able to work out orbits of even *three bodies* accurately. Just recently I have found that all the fundamental equations of the Bohr theory can be deduced without assuming any motion of the electrons at all. You can get the Balmer series, you can get all the lines of the hydrogen atom with the same precision that Bohr gets; you can get some of the fine structure (not all of it—just how far we may be able to go it is hard to say yet, because this work is only a few weeks old, and Bohr's theory is eight years old). But at any rate it seems to me significant that we can get the outstanding facts of Bohr's theory by one assumption in regard to a law of force between electrons and positive nuclei. If we assume that in addition to the ordinary force that we know of, the Coulomb force of attraction, we have also a force  $F$  of repulsion varying inversely as the cube of the distance  $r$

$$F = \frac{1}{mr^3} \left( \frac{nh}{2\pi} \right)^2$$

Here  $m$  is the mass of the electron and  $h$  is the quantum constant;  $n$  is an integer denoting the quantum state of the electron.

Taking that law (which is about as simple a law as you can imagine that would indicate the necessary factors), you find that electrons reach certain equilibrium positions, and in passing from one equilibrium position to another, they would radiate energy in exact accordance with Bohr's theory, and in fact you get precisely the same formulas that Bohr gets, not only for the energy of the atom, but for the distance between the electrons and the nucleus, and the frequency of vibration of the electron about this equilibrium position comes out the same as the frequency that Bohr got for the rotation around the nucleus.

Now it is too early to say that this is proof the electrons do actually have definite equilibrium positions in the atom. It simply affords an alternative way of looking at it. It seems to me that is the most immediate problem for the chemist, to find out whether these electrons are moving or stationary. If they are stationary the problem is a beautiful chemical problem. It is a comparatively simple matter, if you once know the law of force, to find these positions of equilibrium, to figure out where the electrons are in the atomic structures. On that basis the atomic and molecular models that I proposed a couple of years ago could be used almost as they are, with very few changes. That problem, then, is one in which it looks as though we ought to make extremely rapid progress.



On the other hand, if it is a question of orbits, that is going to be a very very difficult problem to work out in detail. But even if it is a difficult problem, there are ways of generalizing, there are ways of getting approximate solutions.

The kinetic theory of gases affords a parallel. The actual phenomena involved in the myriads of collisions between molecules in a gas are of amazing complexity. Nevertheless, by simplifying assumptions such as spherical, hard elastic molecules with attractive forces varying inversely as some power of the distance, it has been possible to account for practically all the properties of gases. Similarly, in the study of chemical relationships, even before we can calculate the exact positions or possible orbits of electrons in atoms and molecules, we may be able to solve enormous numbers of problems by assuming repulsive forces between charged particles, even if these are merely fictitious forces used to replace the unknown centrifugal forces resulting from certain quantum conditions.

In either case, then, whether the atom proves ultimately to be fundamentally static or dynamic, we may hope that chemical relationships and the prediction of chemical and physical properties of compounds can be based upon simple knowledge of atomic structure, and that this knowledge will largely supersede what must now be classed as chemical intuition.

Knowledge of atomic structure thus promises to make chemistry a deductive science, and a science fundamentally simple compared to what it now is.

### Pulp and Paper in 1920

The Federal Trade Commission has recently issued a statistical summary of the paper and pulp industry for 1920. The data on the different grades of paper include: Domestic production, shipments and stocks on hand by months for 1919 and 1920; stocks on hand first of year and end of year and total quantity produced and shipped during year, 1917 to 1920 inclusive. Domestic productions, shipments and stocks of pulp are given by grades for 1917 to 1920 inclusive. Import and export figures on pulp and paper are also tabulated for 1917 to 1920.

From this report the accompanying tables have been prepared, showing production of and foreign trade in pulp and paper during 1920.

Production of paper is classified in grades as follows:

*Total newsprint* includes all *standard news* and special grades of newsprint, but excludes hanging paper, which is shown separately.

*Standard news* is the principal subdivision of *total newsprint*, being 32-lb. paper used for printing newspapers.

*Book* includes all periodical paper and miscellaneous grades of machine finished, supercalendered, coated, etc.

*Total paperboard* includes all grades of board, such as box, straw, chip, tag, press, fiber, binder, leather.

*Boxboard*, the principal subdivision of *total paperboard*, is shown separately beginning with March, 1920.

*Wrapping* includes kraft, manila, fiber, and miscellaneous grades such as glassine, grease-proof, etc., but excludes bag paper which is shown separately.

*Bag* includes paper made into flexible commercial containers such as grocery bags, flour sacks, etc.

*Fine* includes writings, bonds, ledgers, etc.

*Tissue* includes toilet, crepe, fruit wrappers, etc.

*Hanging* includes paper ultimately intended to be

used for purposes of interior decoration, such as No. 2 hanging, oatmeal, tile paper, etc.

*Felt and building* includes roofing, felt, sheathing and other grades of building paper.

*Other grades* include a great variety of specialties that do not classify under any of the above captions.

### DOMESTIC PRODUCTION OF PULP BY GRADES, 1920

	Production for Year, Tons	Used During Year, Tons	Shipped During Year, Tons	Increase of Production Over 1919, Per Cent
Ground wood pulp.....	1,578,300	1,456,198	131,495	9
Sulphite, news grade.....	843,514	717,986	126,261	17
Sulphite, bleached.....	578,081	316,037	262,213	12
Sulphite, easy bleaching.....	72,394	45,309	27,159	9
Sulphite, Mitscherlich.....	82,687	50,404	31,479	4
Sulphate pulp.....	212,888	144,926	65,601	31
Soda pulp.....	431,971	235,808	195,296	14
Other than wood pulp.....	7,821	6,788	1,162	*21
Total, all grades.....	3,807,656	2,973,456	840,666	12

\* Decrease.

Note:—The pulp used and the pulp shipped during each year represent pulp produced in the establishment using or shipping same.

### DOMESTIC PRODUCTION OF PAPER BY GRADES, 1920

	Number of Mills, (Approximate)	Production, Net Tons	Increase of Production Over 1919, Per Cent
Total newsprint.....	87	1,511,968	10
Standard news.....	71	1,380,239	12
Book paper.....	95	1,104,464	27
Total paperboard.....	250	2,313,449	18
Boxboard.....	144	1,378,166	(a)
Wrapping paper.....	148	831,889	20
Bag paper.....	42	211,923	21
Fine paper.....	111	589,322	13
Tissue paper.....	100	177,447	14
Hanging paper.....	24	113,824	24
Felt and building paper.....	53	366,941	30
Other grades.....	92	313,387	50
Total, all grades.....	—	7,334,614	18

(a) Figures for boxboard prior to March, 1920, were included under total paper board.

### IMPORTS AND EXPORTS OF PULP, 1920

	Imports, Net Tons
Chemical wood pulp:	
Bleached sulphite.....	128,206
Unbleached sulphite.....	344,969
Bleached sulphate.....	17,277
Unbleached sulphate.....	182,697
Ground wood pulp.....	233,148
Paper stock other than wood pulp.....	254,755
Total.....	1,161,052
Domestic wood pulp.....	32,133
Rags and other material made from vegetable fibers.....	42,282
Total.....	74,415

### IMPORTS AND EXPORTS OF PAPER, 1920

Imports	Lb.	Value
Newsprint.....	1,459,737,288	\$68,600,950
Book paper.....	4,340,425	496,132
Wrapping.....	4,941,824	460,289
Hanging.....	—	553,791
All other grades.....	—	2,741,238
Total.....	—	\$72,652,400
Exports	Lb.	Value
Newsprint.....	91,951,913	\$5,983,611
Book paper.....	95,689,512	13,765,694
Paperboard.....	—	5,553,094
Wrapping.....	61,264,501	6,994,381
Bag.....	—	2,593,459
Fine.....	—	8,908,230
Tissue.....	—	2,654,529
Hanging.....	—	1,251,743
All other grades.....	—	11,091,952
Total.....	—	\$58,796,693

### Chilean Nitrate Exports for 1920

According to figures kept by individuals engaged in the nitrate business, compiled from periodical official announcements, the total exports of nitrate from Chile in 1920 amounted to 60,679,834 Spanish quintals (1 Spanish quintal = 101.4 lb.). The number of Spanish quintals shipped per month were as follows: January, 9,039,452; February, 6,081,230; March, 5,417,956; April, 5,057,414; May, 5,237,182; June, 2,411,158; July, 3,104,021; August, 4,274,873; September, 5,479,125; October, 4,626,940; November, 3,581,938; and December, 6,368,545.

## Copper:Nickel Alloys

Brief Notes on Structure and Properties of Alloys Used for Driving Bands, Condenser Tubes and Coinage  
—Various Names and Analyses for Nickel Silver Are Tabulated,  
With Notes Upon Their Most Common Uses

By PAUL D. MERICA

Superintendent of Research, International Nickel Co.

ALLOYS of copper and nickel are undoubtedly among the earliest known to man. Thus Muspratt<sup>1</sup> mentions Bactrian coins containing 77 to 78 per cent copper and 22 to 23 per cent nickel dating from 235 B.C. This composition is almost identical with our present nickel coinage alloy. In spite of their antiquity, the pure copper:nickel alloys have not come into the commercial prominence which their unusual properties should perhaps give them, although the recent war, with its large requirements of these alloys for bullet-jackets and driving bands, has served to stimulate interest in them.

Nickel and copper form solid solutions in all proportions, as may be seen from Fig. 1, which gives the equilibrium diagram of this binary series. In conformity with this type of equilibrium the physical properties of the alloys vary continuously with composition, maximum and minimum values being encountered within the series. Fig. 2 shows the electrical resistivity,<sup>2</sup> its temperature coefficient,<sup>3</sup> the thermo-electromotive force<sup>4</sup> and the hardness<sup>5</sup> as they vary. Throughout the entire range of composition the alloys are ductile and malleable; their tensile strength and hardness reach a maximum in the neighborhood of 40 to 60 per cent of copper. Table I gives typical values of the tensile properties for commercial compositions of copper:nickel alloys in different forms.

Baucke<sup>6</sup> has shown that small amounts of nickel increase the toughness of copper as indicated by the notch-bar impact test. He obtains the following results on forged and annealed test bars:

Per Cent Nickel	Specific Impact Work in Kg.-M.
Electrolytic Copper	14.1
0.17	20.0
0.31	22.0
1.52	28.0

Even in small amounts nickel decolorizes copper and its alpha alloys. Thus bullet-jacket stock containing 15 per cent of nickel is practically colorless when freshly cut or polished.

Alloys containing less than 60 per cent of nickel are not perceptibly magnetic, but above that percentage of nickel the magnetism of the alloys may readily be detected with a small magnet.

There are several compositions of copper:nickel alloys in common commercial use. The most prominent are:

(1) Two and one-half per cent (2.5 per cent of nickel) cupronickel for driving bands of shells.

(2) Fifteen per cent cupronickel, used largely for bullet-jackets and by the U. S. Navy for condenser tubes

and feed water heaters, containing from 14 to 16 per cent of nickel.

(3) Nickel-bronze, or coinage-bronze, used for baser currency and containing 25 per cent of nickel.

(4) Copper-nickel, containing 50 per cent of nickel, used for remelting in the manufacture of nickel:copper alloys, and

(5) Constantan, used as one element in the construction of thermocouple pyrometers and also as electrical resistance wire, containing 45 per cent of nickel. Their properties will be noted elsewhere in company with other nickel alloys used for special electrical properties.

Of these perhaps the most interesting, in view of its large use during the war, is the bullet-jacket composition commonly known as cupronickel. These alloys are generally made by melting copper in crucibles together with shot or electrolytic nickel following the practice in melting brass and bronze. The metal has a strong affinity for gases and oxygen and before casting is usually deoxidized with from 0.5 to 1 per cent of cupromanganese in order to secure a sound ingot; it may also

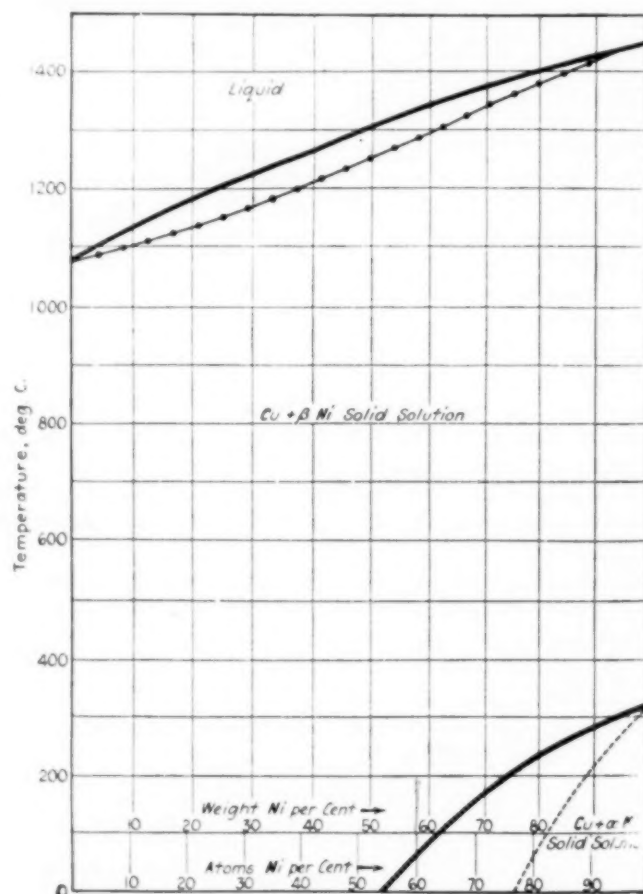


FIG. 1. EQUILIBRIUM DIAGRAM OF COPPER:NICKEL ALLOYS ACCORDING TO GUERTLER'S "HANDBUCH DER METALLOGRAPHIE"

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<sup>1</sup>Chemie, vol. 6, p. 1195 (1898).  
<sup>2</sup>Feussner and Lindeck, Abh. physik. Reichsanstalt, vol. 2, p. 503 (1895).  
<sup>3</sup>Bush, Bull. Am. Inst. Mining Eng., No. 153, p. 2409 (1919).  
<sup>4</sup>Kurnakoff and Rapke, Z. anorg. allgem. Chem., vol. 87, p. 269 (1914).  
<sup>5</sup>Intern. Z. Metallog., vol. 4, p. 9 (1912).



TABLE I. TYPICAL VALUES OF THE MECHANICAL PROPERTIES OF COMMERCIAL CUPRONICKEL COMPOSITIONS

Chemical Composition Per Cent		Form	Yield Point Lb./Sq. In.	Tensile Strength Lb./Sq. In.	Elongation Per Cent
Ni	Cu				
2	98	Tubes, soft†		39,000	44
2	98	Tubes, hard†		63,500	5.5
5	95	Sheet, soft†		39,200	50
5	95	Sheet, hard†		67,500	4
20	80	Sheet, soft†		47,200	35
20	80	Sheet, hard†		90,000	4
25	75	Sheet, soft†		60,500	31
2.5	97.50	Driving band†	14,340	31,770	69.6†
2.5	97.50	Wire (0.08 in. diam.), hard ‡		72,150	1.6†
10	90.0	Strip, annealed†		48,450	28.4*
15	85	Strip, hard†		71,000	3.0*
15	85	Strip, annealed†		47,000	28.0*
20	80	in. rod, hard†	57,800	61,500	14.8*
20	80	in. rod, annealed†	18,000	47,600	40.0*
25	75	in. rod, hard†	58,000	64,000	17.0*
25	75	in. rod, annealed†	21,000	51,600	39.0*
40	60	in. rod, annealed†		69,400	28.0*

\* Elongation in 2 in.

† Values quoted by Hiorns, "Mixed Metals."

‡ Values supplied by an American manufacturer.

be readily deoxidized with magnesium. These ingots are cold-rolled to the size required and annealed at about 700 deg. C.

A striking property of this composition is its greater malleability, as evidenced by the fact that a cast bar 1.25 in. thick may be cold-rolled to 0.040 in. or even thinner, without intermediate annealing. Webster<sup>6</sup> has determined the effect of cold reductions upon the tensile properties of cupronickel as shown below:

History	Tensile Strength, Lb. per Sq. In.	Elongation in 4 In., per Cent	Reduction of Area, per Cent
Normalized.....	50,000	28	63
20 per cent reduction.....	60,000	5	58
40 per cent reduction.....	70,000	3	56
60 per cent reduction.....	80,000	2	53

A typical analysis and tensile test of bullet-jacket material is as follows:

	Per Cent		Per Cent
Copper.....	85.16	Manganese.....	0.11
Iron.....	0.23	Carbon.....	0.029
Nickel by difference.....			14.47

Tensile strength after cold-rolling to 0.040 in. and annealing, lb. per sq. in. .... 46,900  
Yield point, lb. per sq. in. .... 22,300  
Elongation in 2 in., per cent ..... 35.4

<sup>6</sup>Proc., Intern. Assoc. Testing Materials, vol. 7, p. 6 (1912).

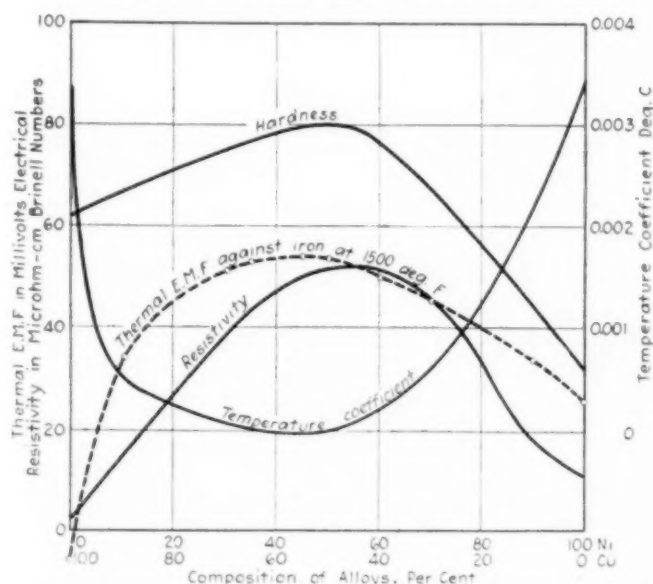


FIG. 2. SOME PHYSICAL PROPERTIES OF Cu:Ni ALLOYS. Hardness is taken on rolled and annealed samples, using a 10-mm. ball and a 500-kg. load

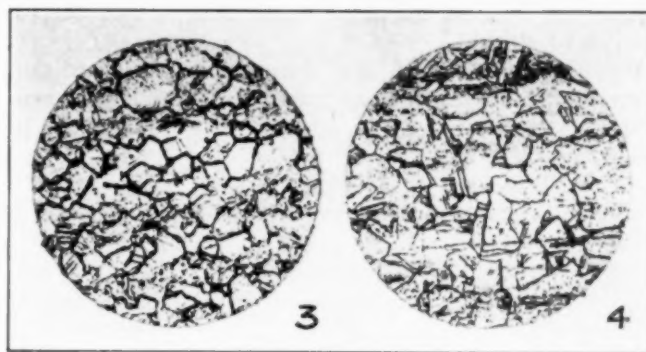


FIG. 3. Cu:Ni HAVING INTERCRYSTALLINE BRITTLENESS.  $\times 150$

FIG. 4. NORMAL CUPRO-NICKEL.  $\times 150$

Both microstructures etched with 20 parts concentrated  $\text{HNO}_3$  and 40 parts glacial acetic acid in 40 parts acetone.

These alloys are also quite resistant to corrosion and are therefore in wide use as Benedict metal for condenser tubes; see U. S. Navy Department specifications 46N1a of 1917. The following values of the tensile properties are typical for this material in tube form:

Outside Diameter, In.	Wall Thick., In.	History	Tensile Strength	Elongation
0.517	0.038	Annealed	43,080	39.0% in 10 in.
0.516	0.036	Light drawn	51,520	8.1% in 10 in.
0.750	0.047	Medium drawn	60,300	4.2% in 8 in.
0.750	0.047	Hard drawn	75,800	2.0% in 8 in.

Bengough<sup>7</sup> has studied the effect of high temperatures on the tensile properties of a 20 per cent copper:nickel alloy.

This metal is subject to a curious type of intercrystalline brittleness at present insufficiently understood. After annealing it frequently is so brittle that it will bend only a few degrees. Under the microscope it presents the appearance shown in Fig. 3, whereas normal annealed cupronickel has a structure shown in Fig. 4, consisting of an aggregate of grains of copper:nickel solid solution. The intercrystalline appearance in the embrittled metal is rather similar to that which occurs on "burning" nickel and Monel metal. By some (see Thompson and Barclay<sup>8</sup>) this brittleness is considered as being associated with the precipitation of graphitic carbon and on this account manufacturers of this metal aim to keep the percentage of total carbon below about 0.04.

The cupronickel alloys are found not to be subject to corrosion- or season-cracking as are the brasses, bronzes and also the nickel:silver alloys.

The composition used for nickel coinage—i.e., containing 25 per cent of nickel, is a very old one. This material has essentially the color of pure nickel, is hard and resistant to abrasion and corrosion; being softer than pure nickel, it is not so difficult to stamp as is the latter. It is manufactured in much the same manner as cupronickel. It is estimated that the total amount of nickel used in nickel coinage is not over 15,000 tons.

A series of alloys containing copper, nickel and zinc is also of very old origin, having been known in China under the name of packfong, or white copper. The most common name for them at one time was German silver, but since the war the trade has accustomed itself to the term nickel silver. The name "nickelene" has been recently suggested by the non-ferrous nomenclature committee of the American Society for Testing Mate-

<sup>7</sup>J. Inst. Metals, vol. 7, p. 182 (1912).

<sup>8</sup>J. Soc. Chem. Ind., vol. 38, p. 130 (1919).

rials. In France, the name maillechort is used for this series of alloys.

Compositions which are in commercial use are quite numerous; they will vary usually within the following limits: Copper, 52 to 80 per cent; zinc, 10 to 35 per cent; nickel, 5 to 30 per cent.

Particularizing, the compositions of nickel silver in common commercial use in the United States are as follows:

	Nickel, per Cent	Copper, per Cent	Zinc, per Cent	Lead, per Cent
Cutlery and knife stock	15-25	55-65	14-20	Fe $\frac{1}{2}$ -1 $\frac{1}{2}$
Key stock	8-18	55-65	15-35	1-2
Jewelers' wire	5-25	53-63	25-32	...
Brazing solder	8-20	35-40	40-55	...
Watch case metal	10-28	55-65	16-30	0-1
Spoon and fork stock	10-20	57-66	20-30	...
Platers' bars and cores	5-25	56-70	18-24	...

Nickel silver is marketed in several grades, depending chiefly on the nickel content, high-grade alloys containing about 20 per cent and low-grade ones less than 10 per cent. Abroad, these are called firsts, seconds, thirds, fifths, etc., but in this country are named according to their nickel content (Table II). An idea of the various trade names which have been given to these alloys may be obtained from Table III.

These alloys are largely used as substitutes for silver and as base metals for plated silverware of all sorts, their suitability for both purposes being due to the fact that their color is very similar to that of silver. They are used in the production of a large number of ornamental fittings and stampings for which an attractive finish and resistance to corrosion are desired and also in the form of wire for small springs and for electrical purposes. Their color varies from a nearly white, nickel color with the higher percentages of nickel to a yellowish white color in the compositions of lower grade or nickel content.

As above noted, the compositions of nickel silver used for any specific purpose are quite variable. It will be understood that lead is added when ready machinability is desired (1 to 2 per cent in key stock); however, it is kept out in material which is to be spun or drawn, as it diminishes the ductility of the alloy.

Analyses of two typical compositions of nickel silver follow:

	No. 1, per Cent	No. 2, per Cent
Copper	63.03	63.39
Lead	None	None
Iron	0.12	0.13
Manganese	0.037	...
Nickel	16.69	18.37
Zinc	Remainder	17.98

The alloys are produced by melting copper together with nickel silver scrap in graphite crucibles, adding the nickel and zinc, deoxidizing with from  $\frac{1}{4}$  to  $\frac{1}{2}$  per cent of cupromanganese and pouring into ingots, which are cold-rolled, with annealing and pickling, into the sheet or strip required, or drawn into wire. The presence of zinc renders this alloy much easier to cast in a sound condition than cupronickel. Annealing is carried out usually at 700 deg. C. in a muffle furnace excluding air.

Copper, zinc and nickel in the proportions used in nickel silver unite to form a single solid solution; these alloys are therefore similar structurally to high and low brass or to copper:nickel alloys, and consist of one (alpha) constituent only. They may be etched with ammonium hydroxide and hydrogen peroxide in the manner used for high brass.

TABLE II. TYPICAL COMPOSITIONS USED IN AMERICAN MANUFACTURED PRODUCTS

Name	Common Use	Per Cent Nickel	Per Cent Copper	Per Cent Zinc	Per Cent Lead
30 Per cent	.....	30	46.67	23.33	.....
25 Per cent	.....	25	50	25	.....
20 Per cent	Spoon stock	20	60	20	.....
20 Per cent	.....	20	53.33	26.67	.....
18 Per cent	Spoon stock	18	65	17	.....
18 Per cent	.....	18	72	10	.....
18 Per cent	Bolster silver	18	65.50	16	0.50
18 Per cent	Spring silver	18	54.67	27.33	.....
18 Per cent	Spinning silver	17.50	67	15.50	.....
16 Per cent	Spinning silver	16	67	17	.....
16 Per cent	Bolster silver	16	56	28	.....
15 Per cent	.....	15	60	25	.....
15 Per cent	.....	15	56.67	28.33	.....
12 Per cent	.....	12	58.67	29.33	.....
12 Per cent	Spinning silver	12	66	22	.....
12 Per cent	Key stock	12	60	26	2.0
12 Per cent	Key stock	12	65	22	1.0
10 Per cent	.....	10	62	28	.....
10 Per cent	.....	10	60	30	.....
8 Per cent	.....	8	61.33	30.67	.....
5 Per cent	.....	5	72	23	.....
5 Per cent	.....	5	63.33	31.67	.....

TABLE III. SOME NAMES AND COMPOSITIONS OF NICKEL SILVER

	Cu	Ni	Zn	
Extra white metal	50	30	20	.....
White metal	54	24	22	.....
Arguzoid	48.5	20.5	31	.....
Best best	50	21	29	.....
Firsts or best	56	16	28	.....
Special firsts	56	17	27	.....
Seconds	62	14	24	.....
Thirds	56	12	32	.....
Special thirds	56.5	11	32.5	.....
Fourths	55	10	35	.....
Fifths, for plated goods	57	7	36	.....
Alfenide	50-70	10-20	5-30	.....
Alpakka	65.2	13	19.5	.....
Amberoid	.....	.....	.....	.....
Argentan	50-70	10-20	5-30	.....
Argentan solder	35	8	57	.....
Argentin	.....	.....	.....	.....
Arguoid	.....	.....	.....	.....
Argozoid	54	14	28	.....
Arguzoid	55.78	13.45	23.2	Sn 2; Pb 2; Orn. Casting
Argyrolith	48.5	20.5	31	Sn 4.03; Pb 3.54
Argyrolith	50-70	10-20	5-30	.....
Aterite	55-60	12-18	13-20	Pb 1-2.5; Fe 6-10
Carbondale silver	66	18	16	.....
Colorado silver	57	25	18	.....
China silver	50-70	10-20	5-30	.....
Craig gold	80	10	10	.....
Electro plate	50-70	10-20	5-30	.....
Electrum	51.5	26	22.5	.....
German silver	.....	.....	.....	.....
Keens alloy	.....	.....	.....	.....
Lutein	.....	.....	.....	.....
Maillechort (typical)	.....	.....	.....	.....
French analysis	66.2	16.4	13.4	Pb 0.15; Fe 3.2; Sn 22
Markus alloy	.....	.....	.....	.....
Neogen	58	12	27	Sn 2; Al 0.5
Nevada silver	.....	.....	.....	.....
New silver	.....	.....	.....	.....
Nickelin	68-55	31-32	0-13	For resistance wire
Nickelin	74.5	25	.....	Fe 0.5
Nickel oreide	66-87	5-10	0-10	.....
Platinoid	54.04	24.77	20.42	Fe 0.5; Mn 0.5
Platinoid	60	14	24	W 1-2
Pope's Island metal	70	14	15	1
Potosi silver	.....	.....	.....	.....
Ruolz alloys	.....	.....	.....	.....
Spoon metal	.....	.....	.....	.....
Silveroid	.....	.....	.....	.....
Silverite	.....	.....	.....	.....
Silverine	.....	.....	.....	.....
Sterline	68	17-18	13-14	Fe 1-1
Sterlin	68.5	17.88	12.84	Pb 0.76
Suhler white copper	40.4	31.6	25.4	Sn 2.6; Co 0.5-0.6
Tutenay	45.7	17.3	37	.....
Victor metal	.....	.....	.....	.....
Virginia silver	.....	.....	.....	.....
White kupfer	.....	.....	.....	.....
White metal	.....	.....	.....	.....
White copper	.....	.....	.....	.....
Wessells silver	51-65	19-32	12-17	Ag 2; FeO $\frac{1}{2}$

An idea of the tensile properties of the copper-nickel-zinc alloys may be obtained from the following table, which gives some typical values for commercial material:

Per Cent Nickel	Per Cent Copper	Per Cent Zinc	Form	Tensile Strength, in 2 In., Lb. per Sq. In.	Elongation per Cent
30	47	23	Strip, hard	130,000	2
30	47	23	Strip, annealed	73,000	32
25	55	20	Strip, annealed	71,000	38
18	64	18	Strip, hard	94,000	2.5
18	64	18	Strip, annealed	58,000	33
18	55	27	Strip, hard	107,000	2
18	55	27	Strip, annealed	69,000	29
10	62	28	Strip, hard	92,000	4
10	62	28	Strip, annealed	53,000	48



## Studies in Colorado Shale Oils

Lighter Hydrocarbon Oil Fractions Found to Be More Saturated Than Heavier Fractions—  
Methods Used in Obtaining Data—Graphical Analysis of Distillation Cuts,  
Showing Temperatures, Saturations and Specific Gravities

BY ARTHUR J. FRANKS

WITHIN the past few years the American shale oil question as an industry has emerged from its position in nebular speculation and is now being fast recognized, not as a mere potential possibility but as a proximate reality. Realizing the intense scientific as well as popular interest in shale oils, the author is pleased to submit this paper as a small contribution to our knowledge, hoping that it will further accelerate the building of an industry that is rapidly assuming definite form.

This investigation was made for the purpose of studying the general character of the crude oils and their fractions and also the distribution and character of the saturated, unsaturated, sulphur and nitrogen compounds in these fractions. Owing to the great difficulty attending the accurate determination of some of the constituents and the identification of others ordinarily found in mineral oils this paper must be considered as the result of preliminary studies only. More thorough investigations are already planned for the future.

The oils studied were all obtained in the Ginnet retort by low-temperature carbonization of shales found in the vicinity of De Beque, Col. These oils were produced during experimental operation. As the shales were from different strata and the conditions obtaining during the various carbonizations were not always identical the oils must show consequent differences. It was to classify and if possible explain these dissimilarities that the first part of this work was undertaken.

### METHODS OF ANALYSIS USED

Since shale oils possess certain inherent characteristics which differentiate them from petroleum, and for other recognized reasons, it was found necessary to depart somewhat from a number of the more or less standard methods of analysis generally used in petroleum technology. In order that the analyses given herein may be of the most value these departures will be given detailed consideration.

Except where otherwise stated the volume of oil taken for a distillation analysis was 500 c.c. A sample of this magnitude yielded fractions large enough for all subsequent investigation. Fractionations were made in 1,000 c.c. Pyrex distilling flasks, except where only small samples were available, in which case a 500 c.c. flask was used. The standard flasks recommended by the United States Bureau of Mines<sup>1</sup> are not suitable for the analytical distillation of shale oils because the high necks, especially when filled with beads, cause excessive cracking of the heavy fractions and great irregularities in the last part of the analysis. Even when proceeding as described above the last oils can escape undue decomposition only by meticulous regulation of the gas flames by the operator. The distillation rate was main-

tained as nearly as possible at two drops per second for the 500 c.c. samples, and at a proportionately lesser rate for the smaller ones. The oils were distilled into 10 per cent fractions, the percentages being expressed by volume. This system of fractionation is superior to that in which the cuts are made on a temperature basis, because the results with the former are more readily and comprehensively represented graphically. Except in one case distillations were carried to complete dryness. All temperatures are given in degrees Centigrade, and are uncorrected for the emergent stem. Bunsen burners were used as a source of heat. The naked flame is required to drive over the last fractions of the oil. Since the gas was often poor and the pressure frequently variable, the temperatures near the end of the distillation sometimes fluctuated more or less. In drawing the distillation curves this was considered and the mean values taken as the true temperatures.

The specific gravities were, in each case, obtained from the Baumé value by conversion with standard tables, and are always expressed at 25 deg. C., which is a convenient and practical basis of comparison. While it is, of course, understood that the ordinary hydrometer is not a very precise instrument for the measurement of specific gravities, it is nevertheless capable of greater accuracy than is possible in the rest of the distillation analysis and is therefore entirely suitable for the present purpose.

### SATURATION PERCENTAGE

The "saturation" of crude oils and fractions is that percentage of volume which is not attacked by concentrated sulphuric acid. This is determined in the following manner. A 9.8 c.c. sample of the oil is measured into a 9 or 18 g. Babcock cream test bottle, the smaller size being used when the expected saturation is less than 50 per cent and the larger size when it is more. Twenty c.c. of concentrated sulphuric acid is then added, the bottle is corked, and the mixture simultaneously cooled and slowly shaken until all violent action has ceased. It is then thoroughly shaken for one minute. Concentrated sulphuric acid is then added until the level of the liquid has risen to the neck of the bottle, which is now immersed to nearly its full length in hot water. When the mixture is quite warm it is immediately centrifuged for about two minutes, the centrifuge running at high speed. Acid is then poured carefully into the bottle until its level below the supernatant oil is plainly visible above the lowest graduation mark, and the centrifuging is repeated until a constant reading is obtained. When the 9 g. bottles are used the percentage saturation may be read directly on the bottle. With the 18 g. bottles the readings must be multiplied by 2 to give the correct value. In the case of very light oils the warming of the mixture before

<sup>1</sup>Bulletin 125.

TABLE I. ANALYSES OF CRUDE OILS

Oil No.	1	2	3	3a	4	5	6	7	8	9
Sp. gr.	0.903	0.901	0.896	*	0.892	0.911	0.946	0.833	0.921	0.933
Saturation	15.0	12.0	15.3	35.0	18.0	17.0	11.7	27.4	*	19.0
Sulphur	0.64	*	0.44	0.43	*	0.52	*	0.51	*	0.53
I.b.p.	65.0	68.0	78.0	73.0	65.0	65.0	*	68.0	90.0	75.0
Water	None	None	2.4	None	1.0	None	0.6	0.2	0.6	8.0
Coke	11.0	8.3	*	*	7.7	11.8	5.3	10.1	11.0	11.0
C.c. sample	500	500	500	300	200	500	500	500	500	500

\*No determination made.

centrifuging is unnecessary and is to be omitted, since there is danger of losing part of the unabsorbed constituents by volatilization. The probable sources of error and the accuracy of the method described are discussed in a publication of the United States Bureau of Mines.<sup>2</sup>

It has been customary heretofore to determine the unsaturated rather than the saturated compounds in mineral oils, this being expressed as that percentage by volume which is dissolved by concentrated sulphuric acid. The remainder was assumed to be the saturated hydrocarbons. But since it is the saturated portion of the oil that is actually measured, and mainly because that part of the oil which is attacked by the sulphuric acid is not necessarily composed entirely of "unsaturated hydrocarbons," it is incorrect to speak of it as such. This error is especially to be avoided in the case of shale oils, since they contain bases and other compounds soluble in sulphuric acid which are not hydrocarbons at all, nor are they even "unsaturated." Therefore the author has discarded entirely this loose expression and uses and recommends the term "saturation" to express that percentage of the oil not acted upon by concentrated sulphuric acid. If it is still desired to express the value of an oil for refining in terms of that percentage which is absorbed rather than

unabsorbed by the acid, then another term, such as "sulphuric acid absorption," should be used, especially for shale oils.

The initial boiling point (i.b.p.) is herein considered as that temperature at which the first drop is seen in the condenser. For oils containing only a small percentage of low-boiling constituents this is more nearly the true boiling point than the temperature at which the first drop is observed in the receiver.

The water is expressed in volume per cent and was determined during the distillation. In cases where more than 1 per cent of water was present the distillation was carried to about 180 deg., the water separated from the light oil and the latter returned to the distillation flask. The fractionation was then carried out as usual.

The coke is expressed in weight per cent of the original oil. The weights of coke were obtained by weighing the flasks before and after the distillation, the differences being, of course, the coke.

The sulphur is given in per cent by weight, and is the average of duplicate analyses which checked fairly well. The method of determination (using nitric acid in the decomposition of the oil) will be described in a subsequent paper.

In Table I are found the analyses of the original crude oils. The data for the distillation analyses are given in Table II, and the saturation of the fractions in Table III.

#### TEMPERATURE, SPECIFIC GRAVITY AND SATURATION CURVES

All the data are represented graphically by the curves in Figs. 1 and 2 which portray the properties of the

TABLE II. DISTILLATION ANALYSES.

Oil No.	1	2	3	3a	4	5	6	7	8	9
Per cent Fraction										
5	147		138	135	102	161	201	107	192	160
10	173	160	169	164	137	189	216	120	221	188
20	226	223	198	200	178	237	231	135	257	245
30	276	263	222	239	211	286	256	152	290	278
40	319	305	252	275	259	314	288	170	322	317
50	320	334	306	303	295	329	310	206	335	340
60	312	347	325	335	305	342	330	264	340	365
70	339	350	350	375	340	346	342	325	345	373
75	...	...	...	380	345	...	327	...	348	...
78.5	...	...	...	340	...	...	...	...	...	...
80	338	350	350	...	340*	352	365	340	354	375
81	...	...	150	...	...	...	...	...	...	...
83.3	...	...	...	...	...	...	...	...	...	320
84.7	...	...	...	...	...	...	280	...	...	270
85	315	...	...	...	...	...	...	...	343	...
86.6	...	295	...	...	...	...	...	...	160	...
90	...	...	...	...	...	360	...	360	...	...
90.5	...	...	...	...	...	340	...	...	...	...
94.4	...	...	...	...	...	...	...	370	...	...
95	...	...	...	...	...	...	...	345	...	...
96.2	...	...	...	...	...	...	...	230	...	...
No. of Fraction										
1	0.757	0.754	0.774	0.760	†	0.770	0.828	0.729	0.809	0.783
2	0.816	0.814	0.824	0.797	0.771	0.829	0.867	0.758	0.830	0.838
3	0.853	0.856	0.863	0.835	...	0.867	0.893	0.763	0.880	0.875
4	0.886	0.886	0.883	0.863	0.842	0.892	0.913	0.780	0.897	0.893
5	0.892	0.893	0.892	0.883	...	0.906	0.924	0.805	0.905	0.895
6	0.892	0.897	0.900	0.897	0.897	0.906	0.926	0.843	0.897	0.887
7	0.880	0.896	0.903	0.912	...	0.906	0.918	0.886	0.899	0.881
8	0.892	0.900	0.859	0.921	0.906	0.908	0.900	0.906	0.914	0.881
9	0.875	0.930	†	...	†	0.933	0.979	0.900	0.914	0.893
10	...	...	...	...	...	...	...	0.925	...	...

\*Distillation not carried to dryness.

†Sample was so small that specific gravities had to be taken on 20 per cent fraction during this analysis.

‡No determination made.



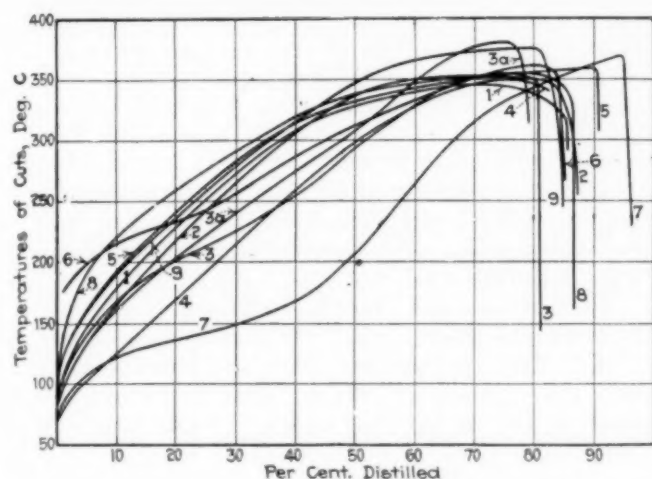


FIG. 1. TEMPERATURE CURVES FOR CRUDE OILS

different oils and their fractions in a very condensed but interesting form. Fig. 1 contains the cut-temperature curves, in which the percentages of oil distilled are plotted as abscissæ and the temperatures as ordinates. Since the boiling point of a complex mixture of homologous or otherwise related compound always rises gradually during a fractionation, the curves representing the distillation should be smooth and free from too sudden irregularities. Great fluctuations must be due to variations in the source of heat, and consequently in the rate of distillation. Hence the curves were drawn with these considerations in view, their paths being through the mean or theoretical values. In Fig. 2 are found the specific gravity and saturation curves, the percentages distilled being again plotted as abscissæ and the specific gravities and saturations as ordinates. Here, as in Fig. 1, the curves are drawn smoothly and strike the mean values wherever fluctuations are marked. In almost every case, however, the curves pass through or very close to the determined points.

Before discussing and interpreting the data from the analyses it is advisable to have more definite information concerning the individual oils other than the general location of the deposits of shale from which the oils were produced. The shales were all crushed to pass a  $\frac{1}{2}$ -in. screen before being carbonized.

Oils 1 and 2 were obtained from samples of shale taken from the same deposit, the exact location of which is not known. It is in the vicinity of De Beque, Col., which is the general source of all the shales herein mentioned. Oil 3 was produced from shale found in the "rubber stratum," on the property of the Monarch Shale Oil Co. Oil 3a is a composite of the fractions obtained from the distillation of No. 3. Oil 4 was made from Mount Logan shale which yielded 45.3 gal. of oil per ton. No agitation was used during the retorting of this

charge. Oil 5 was obtained from shale which yielded 38 gal. of oil per ton. The exact location of the shale deposit is not known, since the sample was gathered at the foot of a high cliff. Oil 6 was made from the same shipment of shale as No. 5; however, the condensers were not functioning properly during the process of retorting and a large portion of the light oil escaped condensation. Oil 7 is a composite of ten samples of oil obtained from the secondary condenser, or that section of the condenser in which the light fractions were condensed. Oil 8 is the composite taken from the primary condenser during the same series of operations. Oils 7 and 8 were both produced from the same shale that was used in making oils 5 and 6. Oil 9 was the product of the carbonization of another sample of shale from the rubber stratum.

## DISCUSSION OF RESULTS

Little need be said about the temperature curves in Fig. 1, since they are self-explanatory. They are all similar in shape, which shows that the oils differ in degree rather than in character. It is remarkable that all the curves show more or less sharp turning points at about 350 to 360 deg., which represents the temperature interval within which cracking occurs in the end fractions. The cracking begins as low as 300 deg., but is very slight at this temperature as compared to that at 350 to 360 deg., which seems to be the range of temperatures in which certain constituents of the crude oils are unstable. It might be expected that the oils which do not crack are those of a more stable nature. This supposition is substantiated by the curve for oil 3a (already once distilled), which shows a less sharp turning point and a steady rise up to 380 deg., the highest temperature reached by any of the oils. The temperature curves for the other oils tend to straighten out at about 350 deg., showing that the light oils formed by the cracking lower the vapor pressure of the heavy oils, and hence the boiling point fails to rise, and even falls rapidly as the cracking becomes more and more pronounced.

The temperature curves for oils 7 and 8 are of special interest since they demonstrate that it is not possible to condense fractionally the oil vapors with any degree of success. This is obvious because the product from the first stage condensers (oil 7) contains a considerable amount of light oils, while that from the secondary condensers (oil 8) contains more than an appreciable amount of the heavy fractions. These results must, unfortunately, explode the theories propounded by a number of inventors of oil shale retorts.

The specific gravity curves in Fig. 2 substantiate the conclusions drawn from the temperature curves. The similarity in shape of the former is further evidence of the likeness in character of all the oils. The more or less sudden rise at the end of most of the curves indicates a sudden increase in heavy fractions and a decrease in their cracking. This is due to abnormal rises

\*Secured by personal communication from A. M. Kivari.

TABLE III. PER CENT SATURATION OF 10 PER CENT FRACTIONS

Oil No.	1	2	3	3a	4	5	6	7	8	9
No. of Fraction										
1	47.0	49.0	42.0	46.0		49.0	39.8	53.6	43.8	49.0
2	40.0	45.0	34.0	44.0	47.0	42.0	34.2	57.2	38.4	42.4
3	33.0	35.5	29.0	42.0		35.0	30.5	56.4	35.2	34.8
4	29.0	30.5	23.0	39.0	36.0	31.2	27.1	52.9	31.2	31.6
5	28.0	33.0	27.0	33.0		28.7	25.1	48.5	29.6	33.9
6	30.0	28.0	29.0	31.0	26.0	29.1	28.5	41.5	31.0	36.9
7	35.0	27.0	31.0	30.0		30.0	32.7	34.0	34.7	41.9
8	33.0	28.0	40.0	30.0	24.0	30.8	37.7	29.9	32.6	43.5
9	42.0	24.0	*		*	27.3	*	35.1	30.1	37.3
10								28.6		

\* No determination made.

in temperature near the end of the distillation caused by the overheating, which resulted in attempts to maintain a constant rate of distillation. With more uniform conditions this would not have occurred and the curves would then have resembled the one for oil 3, which is typical for all crude shale oils (from De Beque shales) when properly distilled. However, it was almost impossible to obtain such conditions with the gas that was used as a source of heat. This will be obvious to anyone who has attempted work of this kind under the conditions that are given.

#### LIGHTER FRACTIONS MOST SATURATED

The significance of the results for the saturation of the different fractions, given in Table III, can be fully appreciated only when studied in connection with the curves in Figs. 1 and 2. The fact that the lighter oils are the most saturated is at once apparent, as well as the generalization that the saturation decreases with increase in boiling point and specific gravity, up to the point where cracking begins. The most remarkable of all the results which this research yielded is now to be noted: the knowledge that the cracking of the unsaturated and unstable oils in the heavy fractions produces lighter oils of higher saturation.<sup>4</sup> This phenomenon, a stranger to petroleum technologists, occurs in every destructive distillation of crude Colorado shale oils that has been attempted, to the best of the author's knowledge. The general trend of the data seems to indicate that the more pronounced the cracking the greater is the increase in the saturation and the fall in the specific gravity and distillation temperature. This is the inevitable conclusion that must be drawn from the fact that each depression in the temperature curve is followed by a corresponding fall in the specific gravity curve and

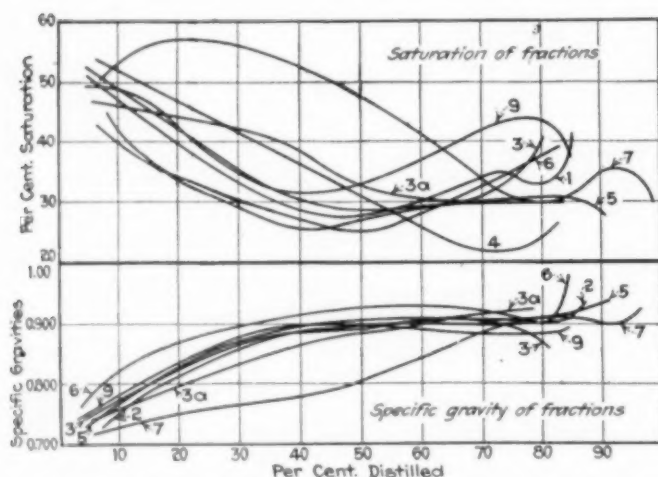


FIG. 2. SPECIFIC GRAVITY AND SATURATION CURVES

a rise in the saturation. The consistency of these phenomena has caused considerable speculation and theorizing concerning their causes, but no entirely satisfactory hypothesis has yet been propounded. The only explanation seems to lie in the fact that it is possible to obtain saturated compounds from certain types of unsaturated compounds, such as resins, or in the possibility that the saturated compounds in the crude oil and the thick, heavy fractions cannot be correctly determined. The first suggestion is by far the most plausible;

yet it is difficult to understand how such a relatively small amount of cracking can result in such an increase in saturation as is found in oil 3a over that obtained for oil 3, the gain in saturation being over 100 per cent. Research is now under way at the Colorado School of Mines with the purpose of determining the causes of and factors that influence the phenomena, so no more will be said about it at present. The reader is free to speculate with the data at hand, and can draw what conclusions he will.

The author takes pleasure in giving credit to C. P. Hackett, who made most of the distillation analyses, and to J. P. Bacca, who made most of the determinations for saturation of the fractions. Thanks are also due to Prof. A. H. Low for his valuable criticisms and suggestions.

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#### Corrosion of Soft Metals

The commercial soft metals include aluminum, tin, zinc and lead. It was shown in Scientific Paper 377 of the United States Bureau of Standards that a type of deterioration designated as "intercrystalline brittleness" may occur in lead under certain conditions whereby the metal crumbles to a coarse crystalline powder. The individual grains of this powder retain all the intrinsic properties of lead, but the bond between the grains has been destroyed.

During the past year a series of corrosion tests has been carried on to demonstrate to what extent such deterioration may occur in other soft metals. The intercrystalline brittleness appears to be largely dependent upon the purity of the metal, and in the pure materials used in the test very slight evidence of such deterioration was obtained. A series of stress corrosion tests has been conducted to supplement Scientific Paper 377 and it has been shown that the simultaneous application of tensional stress to a specimen while corrosion is in progress is a powerful adjunct to deterioration by "intercrystalline brittleness." This is of practical importance, inasmuch as lead—because of its great weight—is often subjected to very considerable stress while in service. Thus the tendency to corrode and become embrittled is accentuated.

#### Canada's Foreign Trade in 1920

Calendar-year figures published in the *Weekly Bulletin* of the Canadian Department of Trade and Commerce show for the Dominion's foreign trade in 1920 an aggregate of \$403,882,150 in excess of 1919 and \$485,847,223 greater than in 1918, last year's total of \$2,639,726,135 comparing with \$2,235,843,985 in 1919 and \$2,153,878,912 in 1918. The share of the United States kept pace with the increasing total trade of the Dominion, forming 55 per cent thereof in 1918 and 1919 and 57 per cent in 1920. On the other hand, trade with the United Kingdom declined, as the following summary shows:

Calendar Years	Total Trade With		
	All Countries	United Kingdom	United States
1918.....	\$2,153,878,912	\$659,442,645	\$1,193,232,877
1919.....	2,235,813,985	626,633,484	1,231,656,516
1920.....	2,639,726,135	574,699,070	1,507,651,074

With imports amounting to \$1,336,921,021, exports to \$1,272,657,442, and re-exports to \$30,147,672, the calendar-year balance of trade against the Dominion was \$34,115,907, contrasted with a favorable balance of \$353,816,759 in 1919 and one of \$333,580,632 in 1918.

<sup>4</sup>Similar results were reported on other shale oils in a paper by C. W. Botkin before the Colorado Section of the American Chemical Society, Nov. 27, 1920, and in a personal communication to the author before this work was undertaken.



## Influence of Copper on Some Physical Properties of Iron and Steel

**A Number of Ferrous Alloys Were Made and the Physical Properties of Forging, Filing, Grinding, Chiseling and Bending Determined—It Was Found That Copper Caused Iron to Be Red-Short and That Manganese or Chromium Removed This Difficulty**

By E. A. RICHARDSON AND L. T. RICHARDSON

**D**URING the past several years a somewhat comprehensive study of the corrosion of copper-bearing irons and copper-bearing steels has been under way, for the carrying out of which a number of iron alloys containing copper were made. In the preparation of these alloys for the corrosion tests and supplementary to these tests certain properties of a physical nature were investigated. This was considered necessary, since the commercial value or the actual use to which any rust-resisting alloy can be put will depend to a large extent upon the various physical properties; in fact these properties will determine whether an alloy would be adapted to a general or to only a specific use. The present paper proposes to deal with these physical properties. The results of the corrosion tests have been already presented before the American Electrochemical Society.\*

The physical properties upon which tests were made were as follows: Forging, filing, grinding, chiseling, bending.

### FORGING

Considering the iron alloys of copper from the general literature, it appears that the forging properties have not been very extensively or thoroughly studied. Although numerous references can be found relating to the effect of copper upon the forging properties of iron and steel, it is a rather surprising fact that the conclusions reached by different investigators are so greatly at variance. However, if one analyzes the results more carefully and divides the alloys into iron:copper alloys and steel:copper alloys, the confusion is not so great. For instance, in five references that were found relating to the effect of copper on the forgeability of iron, four authors<sup>1,2,3,4</sup> state that copper renders iron red-short, while one<sup>5</sup> who worked with wrought iron states that as high as 0.50 per cent of copper causes only traces of red-shortness. Hence, in iron at least, most authorities believe that copper is detrimental to the best forging properties.

In the case of steel, on the other hand, out of twelve references only one<sup>6</sup> states that copper causes red-shortness, ten<sup>7 to 16</sup> say that in reasonable amounts (0.50 per cent copper or less) copper produces no red-shortness, while one<sup>17</sup> even says that copper when added to steel decreases red-shortness. In addition to this, one of these investigators<sup>18</sup> finds that 0.50 per cent of copper is necessary before red-shortness occurs in steel, another<sup>19</sup> believes that 1 per cent copper is needed, while yet another<sup>20</sup> states that 4.70 per cent of copper is necessary to produce red-shortness. Moreover, one man<sup>21</sup> draws his conclusions from laboratory tests and another<sup>22</sup> from many thousands of tons of bessemer rails

containing copper. In the case of steel the fact seems to be that copper in reasonable amounts does not harm the forging properties.

Hence one would conclude from the published literature that copper when added to iron is more likely to cause red-shortness than when added to steel, and that in steel a certain limit exists above which copper causes red-shortness.

Some years ago, while studying at the University of Wisconsin under Prof. C. F. Burgess, one of the authors made a series of alloys of copper and electrolytic iron and in forging these alloys noted this property of red-shortness. Red-shortness shows itself in a very abrupt change from a forgeable to a non-forgeable state; a piece of copper-bearing iron upon being forged down from a white heat would at first be very soft and could be forged with ease, but as a lower temperature was reached the metal suddenly became brittle and would crumble into many fragments under a few blows of the hammer. The resulting fracture had a granular appearance as if rupture had occurred between the grains. Since the present authors hold that the existence of intergranular material has a great effect upon corrosion, and the phenomenon of red-shortness of copper:iron alloys was known before the alloys were made for the corrosion investigation of which this paper is a part, in forging these alloys especial attention was paid to the hot-working properties.

The composition of the alloys made, together with their forging properties, is given in Table I. The alloys were made by melting commercially pure iron in an electric furnace and adding the carbon-free alloying elements to the molten iron. The forging properties were obtained by heating the ingots to a bright red heat and then forging continuously with a hammer to a black heat, this operation being repeated five to ten times (depending on the hardness of the alloy) before the desired shape and size were obtained. The forgings were then thoroughly annealed and the other properties obtained upon such forged and annealed material.

A study of the forging data given in Table I brings several fundamental facts to light. In the first place, it is evident that very small amounts of copper make metal brittle in forging, but that this property appears only during a certain temperature range and that above or below this range forging can be accomplished. Furthermore, our experience has been that the greater the copper content the greater is this interval of non-forgeability and the more difficulty is encountered in obtaining a satisfactory forging. Thus with an iron containing 4.65 per cent of copper (alloy M) forgings can be made only at very low temperatures and much work must be expended.

This phenomenon is also met with in the hot-working

\*See CHEM. & MET. ENG., vol. 23, p. 724, Oct. 13, 1920.

TABLE I

Alloy	Composition		Forging Properties		Physical Properties			Bending	Alloy
	Copper	Manganese			Filing	Grinding	Chiseling		
A	0.04	0.00	Forged at high and low heats.	Smashed at cherry red heat.	Soft	Soft	Soft	Bent flat	A
H	1.97	0.02	Forged at high and low heats.	Smashed at cherry red heat.	Soft	Soft	Soft	Bent flat	H
T	3.22	0.06	Forged at high and low heats.	Smashed at cherry red heat.	Soft	Soft	Soft	Bent flat	T
M	4.65	0.01	Forged at high and low heats.	Smashed at cherry red heat.	Soft	Soft	Soft	Bent flat	M
F	0.04	0.44	Forged at all temperatures.		Soft	Soft	Soft	Bent flat	F
Y	0.41	0.48	Forged at all temperatures.		Soft	Soft	Soft	Bent flat	Y
P	0.48	0.32	Forged at all temperatures.		Soft	Soft	Soft	Bent flat	P
Z	0.62	0.48	Forged at all temperatures.		Soft	Soft	Soft	Bent flat	Z
N	0.92	0.32	Slightly red—short at cherry red.		Soft	Soft	Soft	Bent flat	N
F1	0.36	0.69	Forged at all heats.		Sl. hard	Sl. hard	Sl. hard	Bent flat.	F1
B	0.86	0.69	Forged at all heats.		Sl. hard	Sl. hard	Soft	Bent flat	B
K	0.04	0.93	Forged at all heats.		Soft	Soft	Soft	Bent flat	K
C1	0.36	1.13	Forged at all heats.		Soft	Soft	Soft	Bent flat	C1
E1	0.30	0.96	Forged at all heats.		Soft	Soft	Soft	Bent flat.	E1
R	0.50	1.29	Forged at all heats.		Sl. hard	Sl. hard	Sl. hard	Bent flat	R
E	1.53	1.13	Forged at all heats.		Sl. hard	Med. hard	Med. hard	Bent flat	E
Q	1.87	1.27	Forged at all heats.		Sl. hard	Med. hard	Med. hard	Bent flat	Q
G	0.04	1.60	Forged at all temperatures.		Soft	Soft	Soft	Bent flat	G
L	0.05	1.75	Forged at all temperatures.		Med. hard	Med. hard	Med. hard	Bent flat	L
G1	0.51	1.90	Forged at all temperatures.		Med. hard	Med. hard	Med. hard	45 deg.	G1
H1	1.00	1.81	Forged at all temperatures.		Med. hard	Med. hard	Med. hard	45 deg.	H1
J	0.05	3.11	Forged at all temperatures.		Hard	Hard	Hard	90 deg.	J
S1	0.32	2.34	Forged at all temperatures.		Hard	Hard	Hard	135 deg.	S1
S	3.03	2.78	Forged at all temperatures.		Hard	Hard	Hard	135 deg.	S
W	3.54	2.51	Forged at all temperatures.		Hard	Hard	Hard	135 deg.	W
I	0.04	0.21	Forged at all temperatures.		Soft	Soft	Soft	Bent flat	I
O	0.04	3.30	Forged at all temperatures.		Hard	Hard	Hard	150 deg.	O
U	0.05	3.58	Forged at all temperatures.		Hard	Hard	Hard	150 deg.	U
Alloy	Composition		Forging Properties		Filing	Grinding	Chiseling	Bending	Alloy
	Copper	Chromium							
A	0.04	0.00	Forged at high and low heats.		Soft	Soft	Soft	Bent flat	A
D1	0.05	0.21	Slightly red, short at cherry red.		Soft	Soft	Soft	Bent flat	D1
I1	0.05	0.40	Forged at all temperatures.		Soft	Soft	Soft	Bent flat	I1
A1	0.05	0.46	Forged at all temperatures.		Soft	Soft	Soft	Bent flat	A1
B1	0.04	1.18	Forged at all temperatures.		Sl. hard	Sl. hard	Sl. hard	Bent flat	B1
N1	0.05	1.67	Forged at all temperatures.		Sl. hard	Sl. hard	Sl. hard	Bent flat	N1
M1	0.45	0.18	Red-short at cherry red heat.		Soft	Soft	Soft	Bent flat	M1
L1	0.59	0.20	Red-short at cherry red heat.		Soft	Soft	Soft	Bent flat	L1
U1	0.58	1.76	Forged at all temperatures.		Sl. hard	Sl. hard	Sl. hard	Bent flat	U1
P1	1.14	0.60	Red-short at cherry red heat.		Soft	Soft	Soft	Bent flat	P1
Y1	1.02	1.33	Forged at all temperatures.		Sl. hard	Sl. hard	Sl. hard	Bent flat	Y1
T	3.22	0.00	Very red-short.		Soft	Soft	Soft	Bent flat	T
Q1	2.81	1.63	Forged at all temperatures.		Med. hard	Med. hard	Med. hard	Bent flat	Q1
T1	3.81	2.03	Forged at all temperatures.		Med. hard	Med. hard	Med. hard	45 deg.	T1
Alloy	Composition		Forging Properties		Filing	Grinding	Chiseling	Bending	Alloy
	Copper	Chromium Manganese							
V1	1.09	0.52 1.19	Forged at all temperatures.		Med. hard	Med. hard	Med. hard	Bent flat	V1
X1	1.13	0.88 2.00	Forged at all temperatures.		Med. hard	Med. hard	Med. hard	45 deg.	X1
W1	1.09	1.09 1.98	Forged at all temperatures.		Med. hard	Med. hard	Med. hard	45 deg.	W1

NOTE.—Sl = slightly. Med. = medium. In bending test angles given are interior angles, at which failure occurred.

of a well-known commercially pure iron, which contains copper from 0.03 to 0.04 per cent. The existence of this red-short range has been recognized by the manufacturers of this iron, who advocate that their material should not be worked between the temperatures of about 800 deg. C. and about 1,000 deg. C. Apparently they have never recognized this peculiarity of their product as due to the presence of copper in small amounts, but either have offered no explanation for it or have ascribed it to the well-known transformation of  $\alpha$  to  $\beta$  iron that takes place at about this same temperature.<sup>18</sup> Quite recently another explanation has been given for the brittleness of this iron, in which the cause of red-shortness is said to be due to an intergranular film, possibly iron sulphide.<sup>19</sup>

The writers agree that this phenomenon of red-shortness is probably due to intergranular material, because the fracture has every appearance of being between the grains. However, we believe that the film which becomes weak in the brittle range is copper or some alloy or compound of copper. The fact that the appearance of the fracture, the method of breaking and the brittle temperature of this commercially pure iron are identical with our copper:iron alloys tends to substantiate this belief. The idea that this structure may have some effect on the corrosion of copper:iron alloys has already been enlarged upon in the paper on corrosion.

Another conclusion that can be drawn from the data which is fully as important as the belief that copper

causes red-shortness is the certainty that this can be removed by the addition of manganese or chromium. This easily explains and reconciles the differences noted by earlier investigators where copper was found to make iron but not steel red-short. Iron contains no manganese and the harmful effect of copper is not removed, while in steel the manganese present is sufficient to do this unless the copper is very high. It also suggests that the forging properties of commercially pure iron could be improved by small additions of manganese or chromium. That this would not impair but would improve at the same time the rust-resisting properties has already been shown in another paper.

To illustrate this combined action of copper and manganese, we may cite alloy N, containing 0.92 per cent copper and 0.32 per cent manganese, which was slightly red-short, while alloy P, containing 0.48 per cent copper and the same amount of manganese, forged at all heats. This suggests that for each percentage of copper a certain quantity of manganese is necessary to eliminate red-shortness.

#### FILING, GRINDING, CHISELING AND BENDING

These tests are all of a somewhat similar nature. In the alloys made commercially pure iron was used and carbon-free alloying elements were added. For this reason the alloys are all low in carbon. The results of these tests are given in Table I.

From these data it is evident that when carbon is low,



copper at least up to about 5 per cent does not make iron harder and it does not impair the cold-working properties of iron. Manganese makes iron harder and more difficult to work and when about 2 per cent is reached the resulting alloy is too brittle and hard for ordinary commercial uses. In the same way chromium above about 2 per cent makes the alloy hard and tough and difficult to work, although not brittle.

#### SUMMARY

We may summarize the findings as follows:

1. Copper added to iron produces red-shortness over a certain temperature range. The degree of brittleness and the temperature over which it occurs increase with an increase of copper content. It is believed that this brittleness is due to an intergranular film of copper or an alloy or compound of copper.

2. The red-shortness due to copper is removed by the addition of manganese or chromium, but the amount necessary depends on the copper content. This observation explains why copper added to iron causes red-shortness, while it does not cause red-shortness in steel unless added in excessive amounts.

3. The addition of copper up to at least 3.50 per cent apparently does not impair the cold-working properties of the alloys. Beyond 2 per cent of manganese the alloys become too brittle to work, while with more than 2 per cent chromium the alloys become hard and tough.

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#### Reconstruction of Sugar Refineries in France

The refining of sugar in northeastern France was particularly affected by the war. Nearly all the French sugar refineries were located in the Departments of Aisne, Ardennes, Marne, Nord, Oise and Pas-de-Calais, and in these regions sugar beets were raised in enormous quantities. Of 217 refineries in France, 170 were established in these departments, and 145, valued at \$50,000,000 prior to the war, were destroyed.

The annual pre-war production, which averaged approximately 750,000 tons, fell to 180,000 tons. The present production amounts to about 300,000 tons. Immediately after the war refiners showed some hesitancy in regard to rebuilding their establishments, but Consul Paul H. Cram at Nancy reports that work is going on rapidly at present, and it is expected that practically all the refineries will be in operation in 1925. Of the 47 destroyed in the Department of the Aisne, 22 will resume operation in the course of the present year.

## Problems in the Preparation of Copra and Coconut Oil

BY HARVEY C. BRILL

IN A RECENT number of *CHEMICAL & METALLURGICAL ENGINEERING* (1920, vol. 23, p. 37) Dr. Alvin J. Cox, director of the Bureau of Science, Manila, 1912-19, discussed the various products of the Philippine Islands which assume some importance as commercial commodities to the United States. Among these he gives coconuts and copra a very high rank. According to figures compiled by Dr. Cox (*Bureau of Science Press Bulletin*, 1916, No. 54) the annual crop produced in the islands in 1916 amounted to nearly 500,000,000 nuts. The copra exports were 72,277 long tons and the coconut oil exports 16,091 long tons for 1916.

Since this time the exportation of oil has increased and the copra shipments have fallen off. In other words, more copra is being converted into oil in the islands and this oil is then shipped.

#### THE DRYING OF COPRA—NATIVE METHOD

For the production of oil from coconuts several operations are necessary: The native methods are—where possible—to husk the nuts, divide them into halves and place them in the sun until the meat dries sufficiently to break loose from the shell. They are then removed from the shell and allowed to dry for a further period of time in the sun. When sufficiently dried to be acceptable to the buyer the copra is bagged and sold. The preceding method obviously can be operated only when sufficiently sunny weather prevails to bring about drying, and when one learns that the tropical regions quite often have a marked rainy season he understands that this method would not be successful for year-around operation. It has other handicaps, but the one just enumerated is sufficiently great to make a better method desirable. The second method used by the Filipino is to dry the halved nuts on a grill or tapahan. A trench is dug and over this a furnace is built, which is covered with a bamboo grill. The halved nuts are piled on this grill and a fire of shells and husks is made in the furnace for the purpose of drying the meat. Shells and husks make a poor fire and as a consequence the meat is badly smoked and poorly dried. If an honest attempt is made to dry the meat much of it is scorched and smoked before the exterior of the pile has dried at all.

It is apparent that not enough can be done in the improvement of the methods described to warrant their continued use.

#### USE OF SULPHUR DIOXIDE IN DRYING PROCESS

The Bureau of Science carried out a series of experiments in which the meat was first treated with sulphur dioxide much as dried fruit is treated in California. The results were promising. A twelve-hour treatment with sulphur dioxide was found to give favorable results. The meat lost 37 per cent of its total water content during the treatment and at the end of ten days, during which it was placed in a shed most of the time due to the almost continuous rainfall, it had lost 73 per cent of its total water content. Two effects were produced by sulphuring: (1) The cell walls of the meat were softened and the copra dried more readily afterward; (2) the presence of small amounts of sulphur dioxide prevented the growth of micro-organisms. The disadvantages of the method are the cost of the small sheds

in which the treatment might be given and the length of time needed for drying the copra after sulphuring. However, the oil obtained from such copra is almost water white and will need little refining. The cost of refining oil is estimated at \$4 per each 1 per cent fatty acids per ton of oil, so that oil free from fatty acids is very desirable.

Attempts have been made to introduce artificial driers, making use of hot air. These attempts have met with very little success thus far for two reasons: The machine is expensive in cost and in operation, and a prejudice exists against artificial drying. The belief prevails that a loss of oil results as a consequence of artificial drying. Experiments carried out by the Bureau of Science would tend to disprove this belief.<sup>1</sup> However, Dr. Sherman of the Visayan Oil Co. at Cebu contends that oil collects in its driers in the air outlets. A good opportunity for investigation exists here. What is the best temperature for drying? Is a vacuum advantageous? (Recent developments in drying vegetables prove that vacuum drying is preferable.) And of course the type of drying machine should be considered—one that will minimize handling of copra would be best.

#### EFFECT OF FUNGUS GROWTH

Investigation has shown that the molding of copra will proceed as long as the moisture content is 10 per cent or more. Much of the copra of the Island of Luzon will run as high as 20 per cent moisture content. Such copra when put in a storehouse becomes hot after a short period of storage, and large quantities of carbon dioxide are given off due to the metabolic processes of the fungi. This carbon dioxide reaches a maximum after an interval of three or four days' storage, the temperature recedes and the quantity of carbon dioxide given off decreases. Molding apparently ceases. Has the high temperature been caused by the activity of the fungi? And have they been destroyed by this high temperature? Copra which has undergone such an experience comes out a black, moldy mass with an acid number as high as 25 in many cases calculated as oleic acid. Such oil cannot be refined to an edible oil except at great expense and high loss in oil. Such an experience should not be permitted to occur. Besides the causing of acidity and rancidity of the oil, the molds destroy much of the oil when they grow. Investigations conducted by the Bureau of Science showed that this varied from 20 to 50 per cent of the total oil present.

#### EXPRESSION OF THE OIL FROM THE MEAT

To obtain the oil from copra, the copra is first ground and the heated meat sent through expellers. The most advantageous temperature for this operation is not known in the Philippine Islands. Such data should be determined. The influence of the moisture content on the operation has not been thoroughly investigated and deserves such investigation—i.e., is a residual quantity of moisture helpful in obtaining a high percentage of the oil by expression? Some mills leave a residual oil content as low as 8 per cent after the expeller treatment, others insist that this is not economical because of the wear and hardship on the machinery, and the latter prefer to leave in an oil content of 12 to 15 per cent. They then steam this copra meal and subject it to hydraulic pressure. Here a good solvent would be an efficient helper. A solvent for use in the tropics

must not have too low a boiling point, because of the high temperature of the condensing water.

The copra meal remaining cannot be used as a fertilizer because of its oil content; it cannot be disposed of as a cattle feed, since cattle raising does not flourish in the islands; and for the last five or six years it could not be shipped elsewhere for cattle feed because of the prohibitive freight rates. This emphasizes the need for a solvent and the installation of an extracting process which would leave a cake which because of the absence of any oil would be available for fertilizer purposes.

#### OTHER METHODS SUGGESTED TO SEPARATE THE OIL

It seems that the process of converting coconut meat into copra might be avoided by making use of some method that would take the oil from the fresh meat. Indeed, O. Vyner of British North Borneo reports a recently patented method which does this. When the Bureau of Science attempted to repeat his experiments the experimenters were unable to duplicate his results.

The Filipinos do this on a small scale by pulping the meat, allowing it to ferment for several days, which brings about a disintegration of the cellular matter by the bacteria, warming over a direct fire and then separating the liquid portion from the solid material by means of crude presses. Their yield of first-class oil is small, but the product commands a higher price than the average coconut oil that is on the market.

In the attempt to separate the oil from the fresh meat a number of difficulties are met. The freshly grated coconut meat does not give up its oil readily by pressing. By treating the meat with water and live steam for three hours before pressing, 80 per cent of the oil can be removed by one pressing. Further steaming and pressing would remove a large part of the residual portion. The liquid obtained by pressing is a white emulsion, consisting of cellular tissue, oil and water. How to remove the oil from this is a complicated problem. A De Laval cream separator works fairly well until the bowl becomes packed with the cellular matter. A specially constructed centrifuge, possibly modeled after the wringer used to dry explosives, might be used.

When this liquid was cooled to a temperature of 15 deg. C. and allowed to stand twenty-four hours, then gently warmed to room temperature or slightly above, the oil could be readily separated.

Treatment of the ground meat with hot solutions of acids, bases and various salts either at atmospheric pressure or in an autoclave did not facilitate the separation, but resulted in deterioration by hydrolysis.

The establishment of the drying and pressing method would mean that the nuts would be assembled and the oil manufactured from them at some central point. This would likely be as advantageous for the islands as a whole as the establishment of sugar centrals and the abolishment of the crude, wasteful, native sugar mill has proved to be. It would mean one other thing: that the press cake would be sweet and wholesome and fit for human food and not a nuisance as it now is.<sup>2</sup>

The solution of these problems pointed out and the preparation of pure coconut oil without subsequent refining need two things—men experienced in plant operation and acquainted with chemistry, and men with capital and a willingness to spend some of this in experimental work.

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<sup>1</sup>Brill, Parker and Yates, *Phil. Jour. Science*, (1917), vol. 12, Sec. A, p. 55.

<sup>2</sup>See Parker and Brill, *Phil. Jour. Science* (1917), vol. 12, Sec. A, p. 87.



## Determination of Melting Points

### General Disagreement in Melting Point Values as Given in Handbooks—Suggestions on Methods to Be Used in Determining the True Values—The Melting Point of Potassium Chlorate by a New Method

By CLIFFORD D. CARPENTER

WHEN one wishes to know the melting point of a substance it is most convenient to refer to some handbook containing a table giving a list of substances and their important physical constants. In the case of the important organic substances the melting points are rather definitely stated and not much doubt is indicated, although in a few cases two values are given differing by one or two degrees, but they are oftener given in the tenths. It is quite a different case when one desires to know the melting point of an inorganic compound. If it is listed, a single value may be given, but many are indicated by two results differing from ten to thirty degrees or more. If the value desired to be known has only one value given, it might readily be assumed that it was very definitely known, but if one is unfortunate enough to look into two handbooks, he will likely end in doubt, as it often happens that such tables do not agree. Take, for example, the melting point of potassium chlorate. The values given in three typical handbooks on physical constants are 334 deg.,<sup>1</sup> 357 deg.<sup>2</sup> and 370 deg.<sup>3</sup>

There are two main reasons why the data for the organic compounds are so much more satisfactory than those for the inorganic. Most of them melt at relatively low temperatures where the mercury glass thermometer is satisfactory, when properly standardized, to measure such temperatures. Then, too, the purity of an organic compound is ordinarily defined by its physical constants, usually its melting and boiling point, making a knowledge of such facts especially valuable.

In the case of the inorganic compounds, most of them are beyond the range of a mercury glass thermometer, or at least in the upper part of such range, where considerable difficulty arises in defining the absolute temperature. Then, too, it is not so difficult to determine the purity of inorganic substances, as there are well known analytical methods. When a search of the literature is made it is found that very few of the melting points of inorganic substances have recently been determined. Since the development of accurate temperature-measuring instruments, platinum resistance thermometers, thermocouples, etc., and a careful study of well-defined points for their calibration have taken place only in the last few years, it would seem that much of the present lack and inaccuracy in data for the melting points of inorganic substances is due to the fact that no careful attempt has recently been made to redetermine them. The main considerations in melting point determinations are: The method used in bringing the compound to the desired temperature, the kind and accuracy of instrument used in measuring the temperature, the physical evidence used in recognizing the point at which the compound melts, and the purity

of the compound. The first two involve the question of apparatus. The last two depend upon the nature of the compound under consideration.

#### APPARATUS

A practical apparatus for the determination of many melting points and its arrangement is illustrated in Fig. 1. It includes a stirrer, well-lagged beaker and a platinum resistance thermometer with its Wheatstone bridge, galvanometer and reading scale. The special feature of the stirrer is its adjustability with regard to speed, having three different size pulleys, both on the motor shaft and stirring rod. The stirring rod can be raised and lowered to accommodate the height of the beaker. While the one illustrated is an iron rod with a

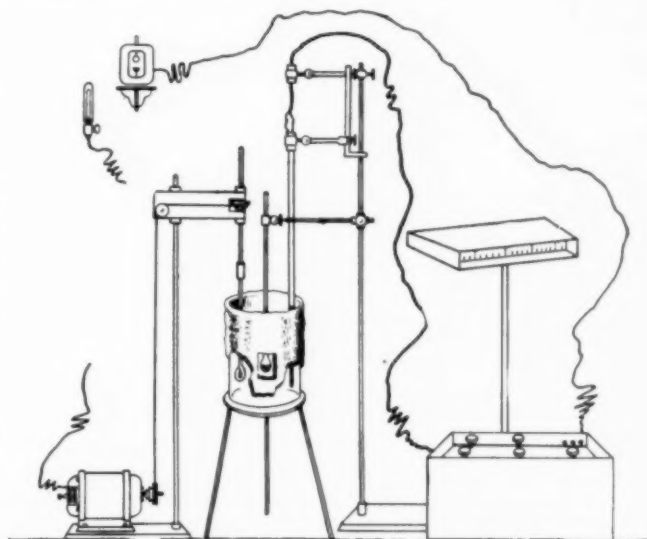


FIG. 1. MELTING POINT APPARATUS

loop in the end of it, a glass rod may be substituted when desirable. The stirring apparatus is an entirely independent unit and can be moved without disturbing any of the other apparatus.

Another convenience is the clamp which carries the platinum resistance thermometer, which prevents the loosening or breaking of the leads at the head of the thermometer. The beaker is lagged by wrapping with moist asbestos paper until about  $\frac{1}{2}$  in. thick. Two small holes are cut in the asbestos, one opposite the other, for windows. A light is placed in front of the one on the opposite side and the experimenter can then observe the behavior of the compound when the tube or bulb that contains it is lowered in the bath until it is in front of the window.

The bath is a mixture of potassium and sodium nitrate with a melting point close to 220 deg.<sup>4</sup> As the

<sup>1</sup>Chemiker Kalender.

<sup>2</sup>Van Nostrand, Chemical Annual.

<sup>3</sup>Kaye and Laby.

<sup>4</sup>Cawth, *J. Phys. Chem.*, vol. 2, p. 207; Scudder, *J. Am. Chem. Soc.*, vol. 25, p. 161; Smith and Menzies, *J. Am. Chem. Soc.*, vol. 32, p. 899.

molten nitrate is colorless and transparent, it offers no obstruction to observing the changes in the compound. The temperature of the bath can be kept within very narrow ranges,  $\pm 0.2$  deg. or less, even at 400 or 500 deg. C. The heat capacity of the molten liquid is great enough that its rate of cooling or heating is slow so that the platinum resistance thermometer registers the slightest change in temperature. With vigorous stirring the bath keeps a uniform temperature. The platinum resistance thermometer and its accessories are assembled as directed by the Bureau of Standards.<sup>3</sup>

#### NATURE OF THE COMPOUND

Some typical cases are discussed below. In the first three, the disappearance and reappearance of solid are the physical evidence. In the fourth case the "rest" in a cooling curve is taken as the point. The fifth case is the typical freezing point curve of a two-component system. In the first four cases it is assumed that the pure substance can be easily obtained.

#### CASE I

*Stable above its melting point, inert toward glass or quartz.* The apparatus above described is used. If temperatures much above 600 deg. C. are to be employed, a transparent quartz beaker as bath and a similar tube containing the compound must be used. The compound is introduced into a long closed tube and lowered into the bath until it is in front of the window. The bath is heated and the temperature is recorded when the solid disappears. The bath is then allowed to cool down slowly and when the solid reappears the temperature is again noted.

Should there be much difference between the temperatures of disappearance and reappearance of solid phase, the undercooling may be prevented by dropping a small crystal into the melt when the temperature is lowered a fraction of a degree below the temperature at which the solid disappears. In practice it has been found that the heating and cooling of the bath by alternately increasing and decreasing the heat may be so controlled that its temperature will change only a small fraction of a degree over any period of time. This makes it possible to keep the disappearance and reappearance of the solid within a very small temperature range. After several operations as described above, the true melting point is obtained as an average of the observations.

#### CASE II

*Undergoing very slow decomposition, or acts very slowly upon quartz or glass.* The compound is introduced into a tube as described in Case I and its approximate melting point determined. After the approximate melting point is known, the bath is set near that temperature and a new sample of the compound in a new tube is introduced and the temperature slowly raised until nearly all the solid melts and then cooled, until the crystals reappear. The temperature of appearance of new crystals and the time which the tube containing the compound is put into the bath and of appearance of new crystals are noted and recorded. The bath is alternately heated and cooled and the temperature and time of each appearance of new crystals are noted and recorded. The lowering of the temperature on each successive reading, as a result of the increase in amount of decomposition products or of reaction between the containing tube and the compound,

is a function of the time, and the effect may be indicated as a time temperature line. By a very small extrapolation of the line the true melting point of the pure compound is determined.

#### CASE III

*Volatile below or undergoing rapid decomposition at its melting point.* The pure compound must be sealed in a heavy walled tube. The quantity of solid introduced should nearly fill the tube. It may then be tied to a glass or quartz rod by a thin iron wire and lowered into the bath until in front of the window. In such cases the tripod supporting the bath should stand in a large iron pan, and should be well surrounded by a jacket with observation windows to prevent serious accidents in case the decomposition pressures should burst the tube. The platinum resistance thermometer should also be protected by a partition between it and the tube containing the compound.

#### CASE IV

*Acts vigorously on transparent tubes, glass and quartz, but is inert toward metals or carbon.* This case is a typical cooling curve problem. The use of this

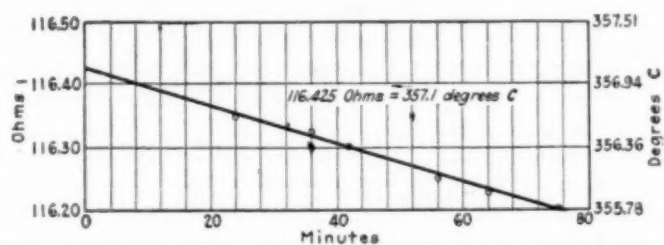


FIG. 2. EXTRAPOLATION LINE SHOWING RATE OF DEPRESSION OF MELTING POINT OF POTASSIUM CHLORATE DURING PYROLYSIS

method is typically illustrated in recording the melting point of a metal in a graphite crucible as employed in calibrating the resistance thermometer.<sup>4</sup>

#### CASE V

*Melting points of hydrates; or a substance difficult to obtain pure but readily estimated when mixed with a second component.* The melting points of the pure substances, the addition products (hydrates, etc.) can be estimated by extrapolation of the "freezing point" curves of such two component systems.

#### THE MELTING POINT OF POTASSIUM CHLORATE

In the determination of the melting point of potassium chlorate, the apparatus described above was used. The temperatures were determined by the aid of a platinum resistance thermometer calibrated against the three points, ice water, water steam, and sulphur-sulphur vapor, as described by the Bureau of Standards.<sup>5</sup>

The method employed was the one described in Case II. Pure potassium chlorate was obtained by repeated recrystallization of a c.p. Merck sample.

Pure potassium chlorate decomposes very slowly at its melting point. If then it is melted and slowly cooled, the reappearance of crystals will take place at a temperature slightly below its melting point. If the temperature is again raised and lowered, the second reappearance of crystals will be at a still lower temperature. If the raising and lowering of the temperature

<sup>3</sup>Reprint 124.

<sup>4</sup>Loc. cit.

<sup>5</sup>Reprint 124, loc. cit.; J. Am. Chem. Soc., vol. 41, p. 748 (1919).



are kept within narrow limits, this lowering will be a function of the time. During the course of this experiment the temperature was kept within  $\pm 2$  deg. of a mean. The crystals were never allowed to disappear completely as the temperature was raised, thus preventing undercooling as the temperature is lowered. The bath was slowly cooled and the appearance of new crystals was especially striking and was accepted as the point at which the temperature was to be noted. The data and its interpretation are given below.

The temperature is recorded in terms of ohms. The record of the readings are given:

	Time.	Ohms.
Introduction of tube.....	2:30	.....
First appearance of new crystals.....	2:54	116.35
Second appearance of new crystals.....	3:06	116.32
Third appearance of new crystals.....	3:12	116.30
Fourth appearance of new crystals.....	3:26	116.25
Fifth appearance of new crystals.....	3:34	116.23
Sixth appearance of new crystals.....	3:45	116.20

It is seen that the extrapolation of the line running through the points taken intersects the ordinate at zero time at 116.425 ohms. The temperature corresponding to 116.425 ohms resistance is 357.10 deg. C.

#### CONCLUSIONS

A brief résumé of methods used and some proposed improvements in determining melting points have been given. The melting point of potassium chlorate has been redetermined by a new method.

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## Legal Notes

BY WELLINGTON GUSTIN

### Corporation Casting Metal Furnished by Contractor Held "Manufacturer"

Who is a manufacturer under the internal revenue act was decided by the Federal District Court in the recent case of Dayton Brass Castings Co. vs. Gilligan. The plaintiff corporation was formed for the purpose of manufacturing and selling brass, bronze, aluminum, white metal and all other kinds of metal castings. The Recording & Computing Co. had a contract with the Canadian Car & Foundry Co. for delivery of a large number of time fuses for shrapnel shells for the Russian Government. Each fuse, when assembled and completed, consisted of forty-five parts. The Dayton company entered into contracts with the Recording company to make for use in fuses, from ingots and patterns to be supplied by such company, certain rough castings, to be paid for by the pound and to be delivered at such company's plant.

The work done by the Dayton company concerned but four of the forty-five parts entering into a completed fuse. None of such four parts was at the time of their delivery fitted for insertion into fuses, but the Recording company was required to further prepare them before they were perfected for use. Therefore the Dayton company contended it was not subject to the war munitions tax imposed by Congress and approved Sept. 8, 1916. For failure to make a return within the statutory time the company was directed to pay as a tax the sum of \$18,860.83 and a penalty of

50 per cent additional (\$9,430.42). This was paid under protest and a claim was preferred for a refund of the tax and penalty, on the ground that it was not subject to such tax. The Commissioner of Internal Revenue ordered a repayment of the penalty, but otherwise rejected the claim. The company began suit to recover, on the grounds that the articles cast and delivered by it were parts of fuses, that in the performance of the work it was not engaged in manufacturing and was not a manufacturer, and that in delivering the castings in the manner provided in the contract it did not sell or dispose of them within the terms of the act.

However, the court held the company was a manufacturer, under the act, and that it was not necessary that a manufacturer produce a finished product. It said castings made for use in shell fuses, though still in their rough condition and requiring numerous processes to prepare them for such use, cannot be used without further treatment for any purpose other than that for which they were designed and are relatively complete parts. It further said that a corporation casting metal and delivering it to the owner "disposes of" such castings.

Again the provision of the act, for determining the munitions tax in case of articles sold below the fair market price to evade the payment of the tax, does not prevent the imposition of the tax on a manufacturer of castings for shell fuses from metal furnished him by the maker of the fuses.

The corporation which received from a munition maker metal owned by such maker, and made therefrom castings for shell fuses, which it returned to such maker, had a lien on the metal for its labor thereon and its profits, which made it a special owner of the metal, taxable under the act imposing a tax on war munitions.

### Sale Contract Held Subject to Rule Fixing Percentage of Estimated Output

In the action by the N. P. Sloan Co. against the Standard Chemical & Oil Co. the U. S. Circuit Court of Appeals affirmed judgment in favor of the plaintiff. The action was on a contract for the sale of the season's output of the seller, estimated at a stated quantity. Both parties were members of a voluntary association called the Interstate Cottonseed Crushers' Association, and the court said such contract was subject to the rule of the association that the seller is required to deliver at least 85 per cent of the estimate, where the contract did not contain an express exception from that rule as required by another rule of the association permitting specific written contracts at stated special conditions.

The contract estimate called for 2,000 bales of linters at 3c. per lb. The Standard Chemical & Oil Co. delivered only 1,324 bales and claimed full compliance with its obligations because it delivered its entire season's production. On the other hand, the Sloan company claimed it was entitled to 1,700 bales, or 85 per cent of the contract estimate. It went upon the market and bought 376 bales of linters, representing the difference in controversy, and paid 8½c. per lb., thereby losing 5½c. per lb. on the contract price. The net loss to plaintiff, Sloan company, at 5½c. per lb. was \$7,312.16 and judgment was rendered for this amount. Further, it was contended by the Standard Chemical & Oil Co. that there had been a settlement of the difference in controversy by an accord and satisfaction. But

such company's own testimony that the Sloan company agreed to accept a specified shipment of 213 bales of linters in full satisfaction of its demands also showed the goods in that shipment were rejected by the Sloan company, with the other's acquiescence, because of their condition.

The arbitration was had in accordance with the rules of the association. The Standard Chemical & Oil Co. did not sign the letter of submission, but received it, and had due notice of the arbitration. The committee's award was that to fulfill the contract a minimum quantity of 1,700 bales of linters, of an average of 475 lb. per bale, at 3c. per lb. was necessary. This award was the same as the judgment rendered after trial.

Defendant contended that the agreement to arbitrate was revoked. The court said it was true that defendant failed to sign the submission and declined to authorize the purchase of linters on its account, but that would not constitute a revocation. Revocation comes about by act of the parties or by operation of law. Now there was no claim of such by operation of law, and before there could have been such by act of the parties there would have to be notice to the arbitrators. Failure to sign the submission was not sufficient.

Again, the court said, an award fixing the number of pounds which should have been delivered according to the average weight of the bales was not beyond the submission of the question whether the seller should deliver a stated number of bales to the buyer. Instead of speaking in terms of bales of linters, it deals in pounds, and fixed the average weight per bale.

#### **Non-Riparian Owner Has No Right of Action for Pollution of Stream**

In a memorandum decision the Court of Errors and Appeals of New Jersey affirmed judgment rendered against the Egyptian Lacquer Manufacturing Co. in its suit brought against the Chemical Co. of America. The plaintiff has a factory in Rahway, N. J., for the manufacture of chemical products requiring a large quantity of water which was supplied to it by the city. In its suit it set out that the Chemical Co. of America had a factory located at or near the Rahway River and emptied therein refuse from its factory above the intake of the city, which so polluted the water furnished by the city that the Lacquer company was injured in its use and the conduct of its business was thereby prevented, to its great injury, and that the defendant knew that the water from the stream was being used by the city to supply its inhabitants.

It was not alleged that either of the parties, or the city, was a riparian owner other than that the Chemical company carried on its business "at or near" the Rahway River. But, said the court, assuming that both defendant and the city are riparian owners, it is clear that the plaintiff, Lacquer company, is not and that there was no contractual relation existing between the Egyptian Lacquer Co. and the Chemical company or between the defendant Chemical company and the city, as to the supply of water. Therefore the question presented in this suit was whether the Lacquer company had the right to maintain an action against the defendant, since plaintiff was not a riparian owner.

The court said: "We may assume in this case that a liability existed in favor of the city as a lower riparian owner for the pollution of the stream by a higher riparian owner; but there the obligation ceased,

for the right of action would not pass to a non-riparian owner merely because the latter had contracted with the city for the furnishing of the water, for his right depends upon his contract with the city, which might provide for the very character of water which was supplied. The liability of the defendant, if any, rests upon his violation of the legal right of a lower riparian owner, unless it had contracted with the plaintiff."

It was not contended that there was any contract between the parties. Neither was this a case of an indictment for creating or maintaining a public nuisance, or for the violation of any law against the pollution of a running stream, but a suit for damages resulting from a special injury based upon the non-performance of a duty which the Lacquer company claimed was due to it from the Chemical company. But the court found that the claims did not present or show the violation of a riparian duty to the injury of another riparian owner; neither did they show any contract between the defendant and the city, even if such a contract could inure to the benefit of plaintiff (which the court was of opinion it could not). Neither was it claimed there was a contract between the plaintiff and the city, nor that defendant, as a riparian owner, owed any general duty to the public, or a special one to the plaintiff.

#### **Right of Stockholder to Inspect Records of Chemical Company**

Seeking to inspect the books of the corporation, C. S. Goddard instituted mandamus proceedings against the General Reduction & Chemical Co. of Salt Lake City, Utah. It was alleged that Goddard wished to examine the books and records of the corporation in order to secure a list of its stockholders for the purpose of selling them stock in the Congressional Oil Co.

The Chemical company further alleged that it was engaged in the business of equipping and operating its plant for the general chemical reduction of ore at Salt Lake City and the manufacture of paint, and to raise funds for such purpose had sold a large amount of its own treasury stock on contracts and part payments; and that plaintiff was sending through the mails representations to such stockholders to induce them to break their contracts with such Chemical company and to buy stock from the plaintiff, to his gain.

Because of such use to be made of the list of stockholders, as alleged, the corporation contended such to be unlawful and the plaintiff not entitled to be permitted to have access to its stock ledger. Further, it was set up by the corporation, plaintiff desired the inspection to make a list of stockholders to whom he could send through the mails misleading and fraudulent advertisements, as he had done on a former list. But this charge, not supported by proof, was held to be insufficient as an excuse for refusing access to the books of the corporation to a stockholder.

Again the Chemical company alleged that the plaintiff was a cut-rate stockbroker and that his purpose in seeking the inspection of the books was to procure a list of its stockholders for threatened blackmailing purposes and for the unlawful sale to the stockholders of stock in another corporation, and to enable him to induce the stockholders to breach their contracts to pay for its stock. This, the court said, states no defense, since the acts alleged were not illegal, and the charge that they were for blackmailing was a mere conclusion.



## Recent Work on Chromium:Tungsten Steel — Methods of Magnetic Analysis

First of a Series of Articles Reviewing the Literature on Chromium:Tungsten Steels, Especially the Work of Japanese Investigators—This Article Contains a Description of the Methods of Magnetic Analysis Extensively Utilized

**B**ECAUSE of the importance of chromium and tungsten in the manufacture of high-speed tool steels any publications of assistance to a rational understanding of the effects of these elements, alone and in combination, are of considerable interest and importance, especially as our knowledge of the constitution of these alloys is incomplete and metallurgists still disagree in interpretation of observed phenomena.

A series of such papers by Honda and other Japanese investigators has appeared, beginning about 1911, which is of added interest because of the pioneer methods of investigation which have been used. A list of the more important ones is appended. They are not readily accessible to English readers, in some cases German translations alone being available; so that a somewhat extended summary appears justified and will be attempted in succeeding issues of *CHEMICAL & METALLURGICAL ENGINEERING*. Magnetic methods of analysis, together with microscopic examination, have been largely depended upon, though other forms of testing, such as thermal analysis and expansion measurements, have also been used and correlated with the magnetic properties. In the present review, a brief description of the apparatus adaptable for metallurgical study will be presented.

### EXPERIMENTAL METHODS USED

Four types of magnetic apparatus have been used in analysis of metals and alloys at normal and elevated temperatures. They are:

- (1) Beam balance.
- (2) Torsion balance.
- (3) Magnetometer.
- (4) Ballistic galvanometer.

Methods (1) and (2) both depend upon the measurement of the force exerted on a specimen placed in a

non-uniform magnetic field. They are the most sensitive and are particularly applicable where feeble magnetization is obtained. The magnetometer utilizes the deflection of a freely swinging magnetic needle caused by a magnetized specimen and has probably the widest range of sensitivity. The apparatus for the ballistic method consists primarily of a test coil surrounding the specimen and connected to a ballistic galvanometer. Neither of these two latter methods will be here described, as the principles involved in their use are well known and widely used.

### THE BEAM BALANCE

The first of the four types of apparatus mentioned above is shown in Fig. 1, in which *ab* is an aluminum lifting arm suspended from a steel knife edge *c* and controls a pointer with a Wollaston wire 0.003 mm. in diameter, the position of which is sighted through a

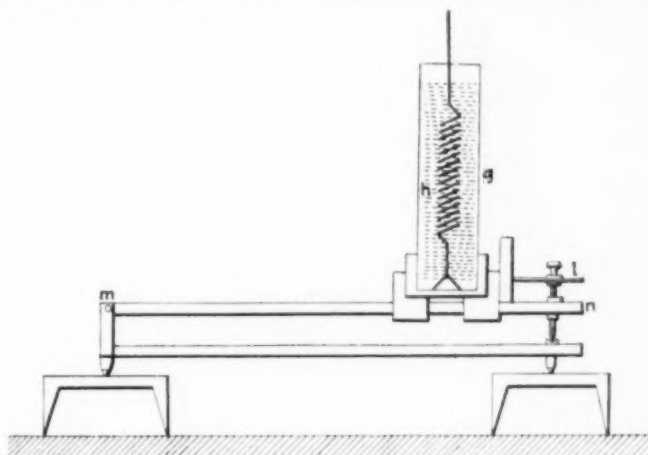


FIG. 2. DETAILS OF SPRING AND OIL FLASK SHOWN IN FIG. 1

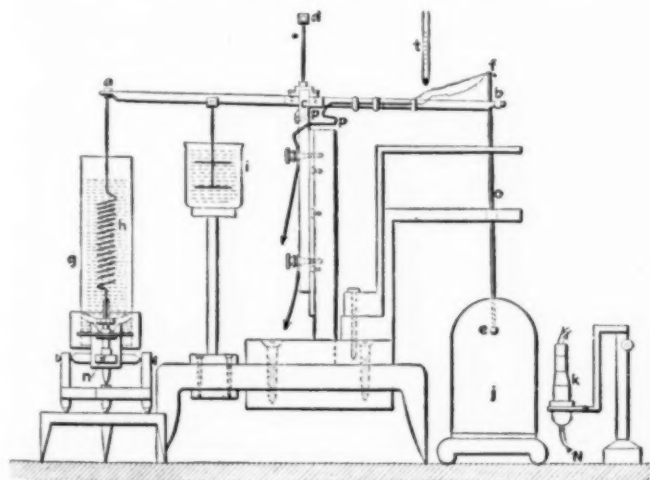


FIG. 1. BEAM BALANCE

microscope. The upper end of a steel spring *h* is attached to one end of the lifting arm, while the lower end of the spring is fastened to the bottom of a Dewar flask containing oil (to prevent rapid temperature changes). This oil flask can be moved up and down the weighing system very slowly while its total dislocation may be read on the torsion head *l*, as shown in Fig. 2, a twist of 1 deg. being equal to a flask movement of  $\frac{1}{2}$  mm. The weighing system is also equipped with an oil stabilizer *i*. A small shell in which the weights are placed is shown at *f*, while suspended from the lower end of a magnesia tube *o* by platinum wires is a magnesia crucible *e*, in which the test-piece is held. Temperatures in the crucible are accurately determined by a rare-metal thermocouple, while the magnetic field in which it

<sup>1</sup>On the Susceptibility of Iron, Steel, Nickel and Cobalt at Elevated Temperatures, K. Honda and H. Takagi, *Sci. Reports*, Tohoku University, vol. 1, p. 229.

is placed is drawn from the poles of a du Bois electro-magnet  $j$ ;  $k$  is an electric furnace, at the bottom of which is a narrow porcelain tube for the introduction of nitrogen in order to minimize oxidation of the sample. The position of the furnace may also readily be adjusted.

The field strength and its gradient may be measured by the induction method. In using the apparatus residual magnetism must first be removed by reversal of current before experimental readings are taken. The force exerted on the specimen may be weighed by this apparatus and is a measure of the magnetic susceptibility of the steel.

#### THE TORSION BALANCE

The torsion balance<sup>2</sup> used by Honda in his early experiments is shown in Fig. 3, and is substantially as follows:

$A$  is an aluminum tube (with a movable counterweight  $E$ ) hung horizontally from a silver wire  $F$  0.17 mm. thick, fastened to a torsion head  $G$  calibrated in degrees and which can be slowly adjusted by a screw. The free wire length can be measured up to its maximum by reference to the fixed peg  $K$ . At one end and at right angles to the tube  $A$  there is attached another similar tube  $B$  which is likewise attached to a magnesia tube  $C$  carrying a small crucible  $D$  suspended by platinum wires. To the other end of the tube  $A$  is fastened a vertical pointer moving before an adjustable scale. A damping apparatus  $H$  hangs freely under the tube  $A$  in a flask containing benzene and glycerine, by which arrangement the movement of the arm  $A$  becomes almost aperiodic. The entire apparatus is inclosed in a zinc box  $ZZ$ . The specimen to be tested is placed in crucible  $D$  and its temperature obtained at any time by a platinum thermocouple which passes through the magnesia and aluminum tubes without disturbing the freedom of motion of the arm  $A$ .

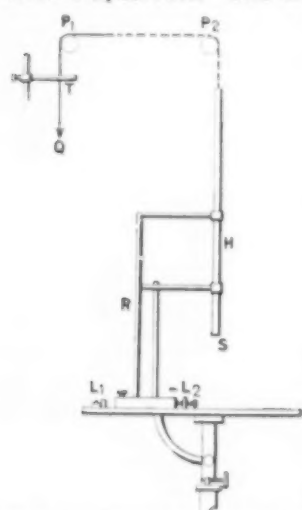


FIG. 4. EXPLORING MECHANISM USED WITH TORSION BALANCE, FIG. 3

A scheme for making field measurements<sup>2</sup> is shown in Fig. 4. A test coil  $S$  is hung vertically by a cord which is guided by the holder  $H$  and passes over two pulleys  $P_2$  and  $P_1$  to  $Q$ , which is used to pull up the coil. The stand  $R$  can quickly be moved through a short distance by  $L_1$  and  $L_2$  to measure the field gradient. The apparatus is placed between the poles of an electro-magnet,  $S$  being vertical to the lines of force, while a ballistic galvanometer is used to meas-

ure induction. The settings are so made that at the upper end of  $H$  the test coil  $S$  is altogether out of the magnetic field. As was the case with the beam balance, magnetic susceptibility of the steel is measured, the intensity of magnetization of the specimen being proportional to the angle of rotation of the arm  $A$  in Fig. 3.

Both beam and torsion balance have a distinct advantage over the other magnetic methods of analysis mentioned in that they are applicable to alloys which are worked with difficulty or not at all, as they do not require specially finished test-bars.

Modifications of the equipment as described have been made from time to time in the various researches carried out by these Japanese investigators, but will not here be described, as a bibliography listing the various publications is given below. In these papers may be found details of various modifications used as well as more elaborate descriptions of the apparatus and methods employed.

#### MORE IMPORTANT METALLURGICAL PAPERS APPEARING IN "SCIENCE REPORTS," IMPERIAL TOHOKU UNIVERSITY

Vol.	No.	Page	Author	Title
1	1	1	K. Honda	Die Thermomagnetischen Eigenschaften der Elemente
1	4	207	K. Honda and H. Takagi	Ueber die Umwandlungen des Eisens und Stahls bei höheren Temperaturen.
1	5	229	K. Honda and H. Takagi	Ueber der Suszeptibilität des Eisens, Stahls, Nickels und Kobalts bei höheren Temperaturen.
2	1	1	K. Honda and T. Soné	Die Magnetische Suszeptibilität der binären Legierungen.
2	1	27	K. Honda and T. Soné	Die Thermomagnetischen Eigenschaften einiger Elemente.
2	2	69	K. Honda	Ueber die Wärmeänderungen und Magnetisierungsänderungen ferromagnetischer Körper bei höheren Temperaturen.
2	4	203	K. Honda and H. Takagi	Die Thermomagnetischen Eigenschaften des Eisens und der Stähle.
3	4	165	K. Honda	Ueber die magnetische Umwandlung und ihre Nomenklatur.
4	3	161	K. Honda and H. Takagi	On the Magnetic Transformation of Cementite.
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4	3	215	K. Honda and T. Ishiwara	On the Thermomagnetic Properties of Various Compounds and Weiss Theory of Magnetons.
4	3	261	K. Honda and H. Takagi	On the Magnetic Study of the $A_3$ Transformation in Pure Iron.
4	5	313	T. Soné	Magnetic Properties of Iron Electrically Deposited in Magnetic Field.
5	1	53	T. Ishiwara	On the Magnetic Susceptibility of Nitrogenide Manganese.
5	2	121	T. Matsuda	On Some Properties of Annealed Steel.
5	2	135	K. Honda, K. Tawara, and H. Takagi	On the Transformations of Special Steels at High Temperatures.
5	3	153	K. Honda and J. Okubo	Ferromagnetic Substances and Crystals in the Light of Ewing's Theory of Molecular Magnetism
5	5	285	K. Honda	On the Temperature of the Reversible $A_1$ Transformation in Carbon Steels.
5	5	325	K. Honda and J. Okubo	On the Effect of Temperature on Magnetization Considered From the Standpoint of Ewing's Theory of Magnetism.

<sup>2</sup>Die thermomagnetischen Eigenschaften der Elemente, K. Honda, Sci. Reports, Tohoku University, Vol. 1, p. 1.



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|---|---|-----|-------------------------------|--|
| 6 | 1 | 23  | K. Honda and<br>T. Murakami   | On the Thermomagnetic Properties of the Carbides Found in Steels.  |
| 6 | 2 | 53  | K. Honda and<br>T. Murakami   | On the Structure of Magnet Steels and Its Change With Heat Treatment.  |
| 6 | 3 | 133 | T. Ishiwara                   | On the Magnetic Investigation of $A_3$ and $A_4$ Transformations in Pure Iron and Steel.   |
| 6 | 3 | 149 | K. Honda                      | On the Magnetic Investigation of the States of Cementite in Annealed and Quenched Carbon Steels.   |
| 6 | 4 | 203 | K. Honda                      | On the Thermal Expansion of Different Kinds of Steel at High Temperatures.   |
| 6 | 4 | 213 | K. Honda                      | A Criterion for Allotropic Transformations of Iron at High Temperatures.   |
| 6 | 4 | 219 | K. Honda and<br>T. Simidu     | On the Thermal and Electrical Conductivities of Carbon Steels at High Temperatures.  |
| 6 | 5 | 235 | K. Honda and<br>T. Murakami   | On the Structure of Tungsten Steel and Its Change Under Heat Treatment.  |
| 6 | 5 | 285 | T. Ishiwara                   | On the Magnetic Analysis of Carbides Found in Different Kinds of Steel.  |
| 6 | 5 | 231 | K. Honda and<br>H. Takagi     | On the Cause of the Irreversibility of Nickel Steels.  |
| 7 | 1 | 43  | T. Matsushita                 | On the Slow Contraction of Hardened Carbon Steels.   |
| 7 | 1 | 59  | K. Honda                      | On the Thermal and Electrical Conductivities of Nickel Steels.   |
| 7 | 2 | 167 | I. Iitaka                     | A Study of Cementite Transformation and of the Equilibrium Diagram of the System Iron-Carbon by Means of Electric Resistance Measurements.           |
| 7 | 3 | 217 | T. Murakami                   | On the Structure of Iron-Carbon-Chromium Alloys.   |
| 8 | 1 | 51  | K. Honda and<br>T. Matsushita | Quenching Cracks in Carbon Steels.   |
| 8 | 1 | 59  | K. Honda                      | On the Moduli of Elasticity and Rigidity of Nickel Steels.   |
| 8 | 2 | 79  | T. Matsushita                 | On the Influence of Manganese on the Physical Properties of Carbon Steel.  |
| 8 | 2 | 89  | K. Honda and<br>T. Matsushita | On Some Physical Constants of Tungsten Steels.   |
| 8 | 3 | 181 | K. Honda                      | On the Nature of the $A_1$ Transformation and a Theory of Quenching.   |
| 9 | 2 | 143 | K. Honda and<br>T. Murakami   | On the Structural Constitution of High-Speed Steel Containing Chromium and Tungsten and the Effect of These Elements on Its Hardening and Tempering. |
| 9 | 3 | 243 | T. Matsushita                 | On Some Physical Constants of Chromium Steels.   |
| 9 | 5 | 401 | T. Ishiwara                   | On the Magnetic Determinations of $A_0$ , $A_1$ , $A_2$ and $A_3$ Points in Steels Containing up to 4.8 per Cent Carbon.                             |
| 9 | 5 | 417 | K. Honda and<br>S. Saito      | On K. S. Magnet Steel.   |

### Increased Costs in English Pottery Industry

Consul W. F. Doty, of Stoke-on-Trent, reports that manufacturing costs in that center of the English pottery industry have increased enormously over pre-war figures. Labor is 150 to 180 per cent higher than in 1913, fuel 200 to 255 per cent higher, clay 160 to 250 per cent, cobalt 230 to 566 per cent, flint, glaze, etc., 180 to 330 per cent, crates and straw 230 to 425 per cent, cartage 300 to 400 per cent, sagger marl and fire-brick 275 to 290 per cent, and plaster 200 per cent higher according to data supplied to the Consul by the Staffordshire Pottery Manufacturers' Association.

## Factors Influencing the Viscosity of Glue

BY F. J. CRUPI

AS is well known, the viscosity of glue solutions generally varies with their comparative water content. A glue solution with a high water content produces high dispersion of the molecules, and a consequent low viscosity; whereas a solution of the same glue with a less water content produces less dispersion and a comparatively higher viscosity.

### GRADES OF GLUE AND COLLOIDAL PROPERTIES

There are many different grades of glue on the market, and it is noticed that a high-grade glue "B" shows a higher viscosity than an inferior grade "C"—each solution containing glue and water in exactly the same proportion. The cause of this may be explained as follows:

The former glue "B" may consist of colloids which are much larger than the colloids of glue "C"—that is, the colloids of glue "B" may consist of more molecules than the colloids of glue "C"; if so, this would decrease the dispersion of the molecules of glue "B" as compared with the molecules of glue "C." When discharged through a pipette, the more molecules there are in a given volume the more force they will exert on the sides of the vessel and the more resistance they will offer to deformation and flow. The colloids of glue "B," having a greater mass and concentration than "C," will obviously offer more resistance to flow. The glue solution "C," consisting of minor colloids and greater dispersion of the molecules, will flow more readily, since it offers less resistance to deformation—the molecules, having more freedom, will produce more flexibility, thus passing through the opening more readily.

A better conception may be formed when we compare this statement as an analogy with the flow of sand grain instead of glue. If we use a special pipette with a definite opening, and fill it with fine powdered sand, it will be found to flow much sooner than a coarser grade. Let's imagine the grains of sand as the colloids and the analogy is complete. But it does not always follow that the relative size of the colloids determines the viscosity. A glue solution may have colloids containing, for example, ten molecules, and another solution containing colloids made up of half as many (five) molecules and still be of the same size. Since the colloids of both glues are of the same size, we would expect to obtain the same viscosity, but it does not always follow, for the former colloids, containing more molecules, will produce more concentration and will offer more resistance to deformation, etc.; whereas the colloids containing five molecules—the molecules being greatly dispersed—will be more flexible and, therefore, would deform easier and flow more readily. In each of these mentioned factors the mutual attraction between the molecules plays an important part also.

The dispersion and size of molecules and colloids in glue are also influenced by various chemicals.

Some chemicals tend to increase the dispersion, and thereby lower the viscosity; while other chemicals act *vice versa*. Still other chemicals will coagulate a glue solution to a more or less extent, which is really the combining of molecules into large colloidal masses. When certain acids are added to a glue solution, they will produce an increase in dispersion and lower the

viscosity. Formaldehyde and others produce a decrease in dispersion and a higher viscosity.

It is obvious how temperature would affect viscosity, since an increase in temperature will increase the distance between the molecules, causing a lower viscosity, while a decrease in temperature is *vice versa*.

Unless pipettes used are identical in bulk, size, shape and in almost every possible way, it will be found difficult to obtain accurate comparative results. The fact that a pipette will discharge water in a given time does not follow that a different pipette—different size, shape, etc.—which also discharges its contents in that given time will give comparative results with glue. A pipette which is twice as large in bulk as another can be adjusted with an aperture which will discharge its contents in the same time, in the former pipette the aperture being twice as large as the latter. The various effects of these differences can be imagined when we review the colloids, etc.

A stop watch is used and its figures adopted as a means of classification. The length of time a solution of glue remains exposed in the hot water bath, before being actually tested, is found to affect the viscosity, as the water gradually evaporates.

#### RELATION OF VISCOSITY TO JELLY STRENGTH

Generally the jelly strength of a glue varies with its viscosity. When a finger or rod displaces the colloidal particles of a cold jelly of glue, they act like small solid rubber balls, the hardest rubber balls offering the most resistance to pressure. So in a glue jelly, its strength depends on the concentration of the molecules or the quantity of molecules which make up the colloids. Thus a glue containing colloids made up of ten molecules would offer more resistance than a glue whose colloids are of the same size and consist of only five molecules. The factor of dispersion also affects jelly strength. There are instances where, although the viscosity is lower than a certain standard, the jelly strength is higher. This may be due to the fact that although the molecules which constitute its colloids are less and more highly dispersed, the force of mutual attraction is greater.

Another reason may be that sometimes a glue may form big colloids with a large number of molecules, whereas another glue may form colloids half as big and containing half as many molecules. Of course, the big colloids would take longer to go through the pipette than the small colloids and thereby have a higher viscosity; but it is found that they have quite the same jelly strength, since the force of resistance would be the same in each arrangement of the molecules.

#### RELATION TO TENSILE STRENGTH, ETC.

Along these principles, then, it should also follow that the tensile strength of the dry glue should vary with the distance and mutual attraction between the molecules. It does not follow that a glue with a strong jelly should always have a strong tensile strength. The relative size of the colloids has very little influence on tensile strength. The characteristic properties of a glue depend on the strength and arrangement of the forces of attraction which hold the molecules together. Hard glues are glues in which the forces that exist between the molecules are very strong and hold them together so that they cannot easily be distorted. An elastic glue is one in which the same forces act to restore its original shape once it has been distorted.

Herman Behr & Co., Inc.,  
Brooklyn, N. Y.

## Recent Chemical & Metallurgical Patents

### American Patents

Complete specifications of any United States patent may be obtained by remitting 10c. to the Commissioner of Patents, Washington, D. C.

**Rust-Preventing Mixture.**—GEORGE S. MORGAN, of Toledo, Ohio, claims the use of the following mixture for preventing rusting and corrosion of metals: Litharge, 1 part; fatty acids, 2 parts; paraffine oil, 60 to 200 parts. (1,364,134; assigned to Edgar G. Behr, of Detroit, Mich.; Jan. 4, 1921.)

**Sulphuric Acid.**—If mechanical burners are employed in the chamber process for making sulphuric acid, the quantity of dust carried by the burner gases is large and this dust is not removed in the usual dry dust chambers. Consequently the acid in the Glover tower is made very dirty and when arsenical pyrites are used is highly arsenical. JAMES BROWN, of Manchester, England, modifies the system of dust removal by adding a wet scrubbing system after the usual dust collector. The gases pass first through a coke-filled tower in which  $H_2SO_4$  of sp.gr. 1.5 to 1.7 is circulated, then through two coke filters in series followed by a blower and a small coke filter to remove drops of acid condensed by the fan. By means of heat-interchanger pipes passing through the dry dust chamber, the gases are reheated by the incoming raw gas. In this way it is possible to produce Glover tower acid of high strength which is waterwhite and is dearsenicated down to 5 to 10 parts per million even when using arsenical pyrites. From time to time the acid circulating in the first scrubber is settled in tanks and the clear liquor separated from the sludge. Specially designed distributors are required to prevent clogging. (1,365,964; Jan. 18, 1921.)

**Continuous Calcination of Carbon for Electrodes.**—High-grade carbon electrodes for certain processes require a carbon of high purity and one as nearly as possible free from contained volatile matter. The principal source of such pure coke is the well-known petroleum coke resulting from the distillation of petroleum. This coke as it comes from the oil stills contains from 6 to 12 per cent, of volatile matter, which must be driven off almost completely (to a small fraction of 1 per cent) before the coke is suitable for the manufacture of high-grade carbon electrodes. This volatile matter is driven off by heating the coke to temperatures in the neighborhood of 1,100 deg. C. and in a manner to prevent contact of the hot coke with the air or other gases which would cause oxidation. Several difficulties have been encountered in attempting to calcine coke by a continuous electrical process. Due to the negative temperature coefficient of resistance, there is a tendency for the current to follow the path first established. This results in overheating a portion of the charge and insufficiently heating the remainder. Furthermore, the raw coke is a poor conductor until the volatile matter has been driven out. WILLIAM HOOPES, of Pittsburgh, Pa., has devised a process which overcomes these difficulties. A furnace of the vertical shaft type is made from three flanged steel sections. The sections are insulated from one another and the upper and lower sections have connections for the heating circuit. These latter sections are lined with carbon so as to provide good electrical contact between the shell and the coke charge. The middle section is provided with an insulating refractory lining. The heated portions of the shell are jacketed for water-cooling. The coke charge is fed continuously through a hopper at the top of the furnace. A portion of the gases escaping during calcination is washed, cooled and circulated counter-currently through the furnace. Cool gas entering at the bottom of the furnace rises through the charge. In this way more even heating is obtained and the charge is conductive by the time it reaches the zone of electric heating. (1,366,457 and 1,366,458, assigned to Aluminum Co. of America; Jan. 25, 1921.)



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## Current Events

### in the Chemical and Metallurgical Industries

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#### Addition to Program Rochester Meeting A.C.S.

The only addition made during the past week to the program for the Rochester meeting of the American Chemical Society was an address by Charles F. Chandler, professor emeritus of Columbia University. He will deliver the principal address at the general meeting the night of April 27.

A cablegram from Mme. Marie Curie to the effect that she regrets that she will not be able to re-arrange her plans so as to arrive in the United States in time to attend the American Chemical Society's meeting was received by Dr. Charles L. Parsons, secretary of the society.

#### Experimental Lecture on Radium

Interest in the forthcoming visit of Mme. Curie to the United States is reflected in the program of the New York Section of the American Electrochemical Society for April 8. Dr. R. B. Moore, chief chemist for the United States Bureau of Mines, will deliver the address of the evening at the Chemists' Club. Dr. Moore will make his address an experimental lecture on radium. He is well qualified to discuss this subject in an interesting manner, as he had charge for the Government of the plant in Denver which produced about 7 g. of radium salt for the National Radium Institute and the Bureau of Mines.

#### Recent Advances in Organic Chemistry

Prof. James F. Norris of the Massachusetts Institute of Technology addressed the Philadelphia Section of the American Chemical Society at its regular meeting on March 17, at the Engineers' Club. His subject was "Recent Advances in Organic Chemistry," and with the aid of lantern slides he gave an exceedingly interesting review of the progress in this branch of science during the past ten years.

Many reactions known heretofore only in textbooks have become of great industrial importance. For example, the conversion of ethylene to glycol and of pentane to amyl acetate involve reactions that have been known for years, but it is only recently that anyone thought seriously of operating them on a commercial scale. Propylene is now recovered from oil-cracking stills and is converted into isopropyl alcohol, which shows great promise as a substitute for the ethyl variety. The action of chlorine on acetylene produces dichlorethylene and tetrachlorethane, which are now finding application as solvents.

#### SYNTHESIS OF NATURAL PRODUCTS

The synthesis of natural products may be called the second chapter in the recent progress of organic chemistry. The structure of turmeric has been shown to be similar to that of acetylacetone. Fischer synthesized tannin from gallic acid and certain glucosides. The speaker paid a tribute to Willstätter for his work on chlorophyll and the coloring matters of flowers.

The rubber molecule is now believed to contain a ring of twenty carbon atoms, formed by the condensation of five isoprene chains. About twenty-five different syntheses of isoprene have been developed. Much of this work was done in Russia, as prior to the war Russia held the leadership in the field of paraffine compounds, just as Germany did in aromatics. Besides this extensive work on isoprene, Russian chemists have studied the polymerization of other hydrocarbons and have prepared many different substances with the physical properties of caoutchouc but differing from it chemically. The German synthesis of rubber during the war started with the hydrogenation of acetone, followed by dehydration to produce methyl-isoprene. After this material had been allowed to polymerize for about four months, a so-called "methyl-rubber" was obtained.

In the realm of sugar chemistry marked progress has been made. The preparation of ethers and esters of the various sugars has been especially valuable in studying the tautomerism and ultimately the constitution of these compounds. The speaker praised the recent excellent work of Hudson in this field.

#### FERMENTATION AND ENZYME REACTIONS

Fermentation processes and enzyme reactions have come into prominence during the past few years, especially on account of the production of acetone and butyl alcohol in this manner during the war. Fats can now be produced by the fermentation of carbohydrates, the reaction being controlled by the addition of sodium sulphite. Great progress may be expected in the near future through this control of enzyme reactions by the addition of inorganic salts.

#### CATALYSIS

In discussing the progress in synthetic methods, the importance of catalytic reactions was emphasized. Much has been learned regarding the specific properties of different catalysts. For example, nickel is especially valuable for hydrogenation, copper for dehydrogenation, and the oxides of aluminum or tungsten for dehydration. The development of catalytic promoters shows great promise. The enormous production of acetaldehyde, acetone, acetic acid and alcohol from acetylene was cited as one of the best examples of the commercial application of catalysis in organic chemistry. These processes were operated successfully in Canada during the war, and the yields and efficiencies were extraordinarily high for organic reactions. The production of many other compounds from acetylene is now being studied, such as pyridine, thiophene and acetic anhydride.

Regarding the question of valence, a great deal of evidence has been accumulated in favor of trivalent carbon and univalent and quadrivalent oxygen. Hexaphenyl-ethane and other compounds containing only carbon and hydrogen have been found to ionize and conduct electricity. It may be that the long sought "free radicals" will some day be produced. Electronic conceptions are destined to play an important part in future developments.

#### APPLICATION OF PHYSICAL CHEMISTRY

The greatest advance in the past ten years, in the opinion of Prof. Norris, has been the growth of the dynamic conception of the organic molecule. We used to think that the carbon and hydrogen atoms "stayed put" just the way we drew the lines in the structural formula, but the present tendency is to think of the molecule as a seething mass of moving atoms. The extensive work on tautomerism and desmotropy has been the chief cause of this dynamic conception. Equilibrium studies of the keto and enol forms in a wide variety of solvents have been especially valuable. Many organic reactions have recently been found to be reversible, thus making it easier to apply the laws of thermodynamics. In conclusion the speaker stated that he believes the application of physical chemistry to organic reactions offers the greatest opportunity for advancement at present and in the immediate future.

#### To Visit Mining Experiment Stations

Plans for the work at several of the mining experiment stations of the Bureau of Mines during the next fiscal year will be discussed at conferences which will be held at these stations between Director Bain and Dorsey A. Lyon, supervisor of stations, and the local staffs. Messrs. Bain and Lyon will leave Washington April 10 and will visit the stations at Bartlesville, Rolla, Mo., St. Louis, Minneapolis and Birmingham.

### Ceramic Appropriation Fails in Ohio

The Ohio Legislature has failed to include in its appropriations the \$15,000 item proposed as the state's part of the co-operative support being given to the Bureau of Mines ceramic station at Columbus. The station soon will have been established four years, but the only appropriation which has been forthcoming is that allowed by the Federal Government.

The failure of Ohio to appropriate for this station probably will be called to the attention of the ceramic industries in that state in order that they may bring home to their legislators the benefits accruing to Ohio by reason of the location of the station within its borders.

### Wage Changes at Holyoke Paper Mills

The American Writing Paper Co. after a conference with the leaders of the various local labor unions has announced a cut in wages averaging 15 per cent. The reduction is not horizontal, as recent wage advances in case of certain classes of labor had decreased the differential between skilled and unskilled labor farther than was considered necessary or desirable. This factor was considered in the new rates.

The independent mills of the district have for the most part declared their intention of reducing wages in general accord with the policy of the American Writing Paper Co.

The Crocker McElwain and Chemical Paper companies of Holyoke have reached an agreement with their union help on the individual contract question. Both sides made some concessions. At present the veteran employees are being paid on a salary basis and are reporting for work daily although the mills are operating only two days a week.

There is no question that the laboring men as a whole are well pleased with the arrangement and the company should be able to retain its best men in this way and so reduce its labor turnover.

### Water Service and Wood Preservation Discussed By Railway Men

The week ended March 19 marked a time of importance to the railway technical profession assembled in Chicago. The National Railway Appliances Association at the Coliseum presented exhibits of unusual importance in every phase of the railway field, the railway section of the American Association of Engineers discussed education and salaries and the American Railway Engineering Association held technical sessions at the Congress Hotel.

Among the list of papers presented at the latter meetings and of interest to readers of CHEMICAL & METALLURGICAL ENGINEERING were the reports of the committees on water service and wood preservation abstracted in the following paragraphs.

#### EXPERIMENTAL EFFECT OF INCRUSTATION ON PIPE LINES

A large proportion of stoppages in pipe lines is due to corrosion, or roughening of the interior surface. Where pipe is well coated before laying trouble of this nature is not generally to be expected with ordinary water for a number of years. This corrosion usually forms the foundation for other deposits by roughening the interior of the pipe. The amount of deposit depends entirely on local conditions.

Mud or suspended matter other than found as a result of water treatment seldom forms a deposit in the pipe unless the foundation has been already laid by corrosion. The amount found depends largely upon the nature of the water and the velocity of the flow. Snails and similar growths are frequently found in suction lines, but little information is to be found on the subject.

Iron, manganese or aluminum promotes the growth of various forms of crenothrix in pipes or reservoirs. There is also a large variety of bacteriological growth known more familiarly as pipe moss, pipe sponge, etc. It is claimed that these organisms will not thrive unless the water is acid. Anything tending to make the water alkaline will reduce or cure the trouble. Filtration may or may not assist. To be of value the filter must be of a nature to remove the bacteria or their food, or both. Many filters fail to remove bacteria, although they may lessen the difficulties.

The usual sequence is for the pipe to roughen through corrosion. Then mud or slime is deposited to form a culture bed for a variety of growths. Incrustation due to water treatment is commonly found in treating plants of various types. This deposit is greatest when the water is under-treated or when raw and treated waters are mixed in the pipe lines. There is also difficulty due to water being used before the reactions are complete. There is no evidence that filters will entirely eliminate incrustation, as a reaction frequently takes place after the chemicals pass the filters. This deposit is usually found in annular rings of various degrees of hardness.

The application of heat will deposit a scale largely composed of the combination of lime and magnesia. In treated water the changes in temperature will also cause a deposit. When the temperature rises in passing from the treating tank, any excess of lime or magnesia will deposit. The reverse is true of soda. As any excess is generally carbonate of lime, the latter is usually the main source of deposit.

The methods of cleaning pipe vary from hand and mechanical treatment to chemical methods. Valves, etc., around treating plants or where treated water is used are usually cleaned by use of hydrochloric acid. The pipe lines can be cleaned by the same process, but the cost is often prohibitive unless chemicals are recovered. It is better to prevent these troubles than to encounter them later.

Prevention may be accomplished by flushing, which is entirely mechanical, and may be used if the local conditions are proper. It will seldom prevent the formation of chemical deposits and will often assist them where raw water is used to flush a line. Aeration before pumping will aid when the water contains iron and produces crenothrix.

The prevention of chemical reactions in the pipe line will as a rule stop all incrustation. It may be said, however, that the better and more complete the water treatment the less the trouble will be. No method has been devised which will eliminate temperature changes and their resultant effect. Pipe cleaning will pay if there is a shortage when the cost of cleaning is less than the cost of an additional pipe line needed for adequate service.

#### SODIUM FLUORIDE AS A PRESERVATIVE FOR CROSSTIES

Sodium fluoride has been used only in small amounts for experimental purposes. Comparatively small amount is available for preservation of ties at this time. Lack of demand and immediate shortage of high-grade fluorspar have deterred manufacturers in increasing their facilities for its preparation. This recovery of a byproduct from the manufacture of phosphate fertilizer is not being carried out because of the high initial outlay in plant construction and the present conditions of labor and material shortages.

Tests on toxicity of sodium fluoride as made at the Forest Products Laboratory indicate it to be about double that of zinc chloride. Service tests on ties treated with this salt have not been carried on over a period sufficiently long to determine that this same ratio holds true in practice. Until this information is at hand no railroad will go into the extensive use of sodium fluoride for the treatment of ties. Under the circumstances, the comparative prices of zinc chloride and sodium fluoride will determine whether or not the former will be supplanted by the latter, wholly or in part. Recent developments indicate that there is a possibility that sodium fluoride will be obtainable at a price very near that of zinc chloride.

#### PROTECTION OF PILES IN INFESTED WATERS

The committee presented a paper on the protection of piles in water infested by marine borers. The conclusion was that when piles are used in important structures in infested waters where the best protection is desired they should receive in addition to a thorough treatment with creosote oil some form of mechanical protection best adapted to the conditions.

Further, that generally at points on the Gulf and Pacific Coast creosoted piles should have full length mechanical protection to insure protection against *Limnoria* as well as *Teredo*. At Atlantic coast ports creosote treatment will stop the *Teredo*, but mechanical protection is necessary to resist the *Limnoria*.



### Forest Products Laboratory Appropriation Increased

The appropriation for carrying on the work of the Forest Products Laboratory at Madison, Wis., for the coming fiscal year was increased by the last Congress to the extent of \$100,000, or approximately 44 per cent. While this is less than the amount asked for by the Secretary of Agriculture, it is nevertheless a substantial and gratifying recognition by Congress of the needs of the laboratory in carrying on the excellent service it is rendering the industries.

### Research on Colorado Clay Resources

The board of directors of the Civic and Commercial Association of Denver has passed a resolution urging the Colorado General Assembly to appropriate \$5,000 for the use of the State Geological Survey in making an extensive investigation of the ceramic resources of the state. This action is based on the report of the Industrial Research Committee which is abstracted below. This study sought to determine the character of the technical investigations which must be made in the ceramic resources to get the attention and confidence of men actually engaged in the industry, as well as to determine the broad economic forces upon which the industry had been built in the great Ohio district in so far as these forces might force a way to a parallel development in Colorado.

The work includes interviews with users, manufacturers, dealers, clay brokers, ceramic experts and officials of the U. S. Bureau of Mines and the Bureau of Standards, all of whom testified to the high quality of clay products made in Colorado.

The general economic forces which have elsewhere built up a localized pottery industry are represented in Colorado's conditions—namely, that the product combines high value with small bulk, and will bear transportation charges; that there are large supplies of coal close at hand; that climatic conditions are such as to overcome the industrial disease tuberculosis. Probably no plant in the United States gets so large a proportion of raw materials so close at hand as does the Coors Pottery at Golden. There are in Colorado large supplies of excellent fireclay, needed in making "saggers."

The progress of the existing Colorado plants shows that clay workers can be trained as they have been trained by the Coors Co., at Golden, by the Western Pottery Co., and by the Denver Terra Cotta Co.

Negotiations are going forward with Prof. R. D. George, looking toward an extensive investigation of ceramic resources of the state, including the availability of raw materials for the manufacture of pottery, especially white ware. Preliminary ceramic tests, fusion and color tests will be made.

### Industrial Applications of Colloid Chemistry

Dr. Harry N. Holmes addressed the Connecticut Valley Section of the American Chemical Society at the regular March meeting held at the Hotel Bridgway in Springfield, March 18. His subject was "Colloid Chemistry and Some of Its Industrial Applications."

He exhibited a large number of gels and emulsions, some of the former illustrating crystal growth in such media. One in particular, showing crystals of gold in a silica gel, has attracted much interest among geologists because of the plausible explanation of the occurrence of gold in quartz as being the residue from such an original condition in the earth. According to this hypothesis the gold has crystallized in the gel which has subsequently been dehydrated and the resulting silica has crystallized as quartz.

Prominent among the industrial applications of colloidal chemistry that Dr. Holmes described is colloidal silica as prepared by Patrick, originally for an absorbing medium for gas masks. This new material seems to have a wide field of usefulness on account of its high degree of absorption for certain compounds. At present it is being used to clean up the gases from chamber acid plants and recover oxides of nitrogen as well as escaping SO<sub>2</sub>. Its remarkable affinity for water makes it as good as calcium chloride for drying. A large number of important industrial uses have

been suggested for it and some of them are now in the experimental stage. Among these are its use in drying air for blast furnaces and for absorbing gasoline vapors.

The ceramic industry is now being served by studies of colloids. It is possible to work clay with smaller amounts of water if alkali is added. This means a smaller amount of water to be evaporated and less shrinkage of shaped objects. It is also possible to separate iron from clay to a considerable extent by the addition of the proper amount of alkali, for the clay suspension is stabilized by the acid, while the iron, carrying an opposite charge, is readily coagulated in an alkaline solution and settles out. The use of tannins and other extracts is also being studied.

In the preparation of such emulsions as are used in the manufacture of greases there is a great deal of research for the colloid chemist to undertake. The development of colloidal fuel was also touched on as showing an important application.

Among other problems he listed as important the development of a waterproof glue, a product which the Forest Products Laboratory is interested in because of the probability that in the near future there will be no more big timber and it must be replaced by laminated structures.

He also spoke of the degumming of silk and of wool scouring as important industries to which the study of the colloidal state was necessary to work out improved methods.

The proper disposal of mill waste in general, he said, was very apt to be a problem of getting rid of fine suspensions and a study of the specific problem in the light of present-day knowledge of the colloidal state was often the only way to solve the problem.

### Institute of Chemistry

The March meeting of the New Jersey Chemical Society on the evening of the 14th was addressed by Dr. E. Newton Harvey, professor of physiology, Princeton University, on animal light and was illustrated by the production of light from the dried remains of a small crustacean which has this remarkable ability.

Dr. Charles Baskerville, of the College of the City of New York, then told the society of the work which had been done in collaboration with Dr. Gwathmey in the production of anæsthesia without the untoward symptoms associated with the inhalation of ether.

The committee on the possible Institute of Chemistry then presented the following report:

#### REPORT OF THE COMMITTEE OF THE N. J. CHEMICAL SOCIETY ON A POSSIBLE INSTITUTE OF CHEMISTRY

To the Members of the N. J. Chemical Society:

Your committee prepared a tentative scheme and gave it fairly wide publicity, sending it to the journals and prominent chemists and discussing the matter with many. From the printed and written comments and conversations it appears that there are three groups of opinions.

1. That an American Institute of Chemistry is not needed.

2. That an Institute of Chemistry should exist as an adjunct to or function of the American Chemical Society. No one holding this view points out how the American Chemical Society could so function, we are advised to bring the matter to the attention of the officers and Council, as was done about fifteen years ago.

3. That an Institute of Chemistry, to function, in general, as outlined, is needed; that it should be started by the New Jersey Chemical Society, beginning in New Jersey and showing by experience its advantages and developing working plans adapted to the entire country.

Your committee recommends:

A. Anything done should be handled locally, by the N. J. Chemical Society and not by a new organization.

B. That, in view of the fact that even the simplest listing, etc., will require time and money, the entire matter be referred to the board of governors for further action.

The committee extends to all who have answered its questions their hearty thanks for the interest taken in the matter.

GEORGE T. COTTLE,  
C. P. TITUS,  
F. D. CRANE, Chairman.

### Drafting of Tariff Bill Starts

The Ways and Means Committee of the House of Representatives has begun the work of drafting the permanent tariff bill which is to be submitted to Congress at the extra session. The sub-committee charged with the drafting of the chemical schedules is composed of Representatives Longworth, of Ohio; Copley, of Illinois; and Hadley, of Washington. Mr. Longworth has given specialized attention to chemical matters for many years, but the other members of the sub-committee have made no special study of the subject.

The chemical sub-committee is meeting twice a day. At this writing, attention is being concentrated on testimony from representatives of Government departments. The work has not progressed far enough to permit any definite statement as to plans, but Mr. Longworth states that it is evident that the chemical industries must have more protection than is afforded by a tariff. He states that he is not insisting on his licensing plan, but he believes either that or the selective embargo proposed by the Senate must be resorted to. He expressed the opinion that the chemical schedule, above all others, can justify high rates of duty from the fact that it places very little of the burden on the consumer. As an example, he cited the dye in a suit of clothing. The duty paid on that amount of dye would be insignificant even were the schedule very high.

Mr. Longworth commended very highly the work which has been done by the Tariff Commission. This body has been able to furnish the committee, he said, with very pertinent information on every commodity concerning which members of the committee had inquired.

### Dust Explosion Wrecks Chicago Elevator

The Chicago & Northwestern Terminal elevator, leased to the Armour Grain Co., at Torrance Ave. and 122d St., South Chicago, Ill., was wrecked by dust explosion on Saturday, March 19. Of the \$4,000,000 worth of grain in the elevator about \$1,000,000 was lost. Six men on duty also lost their lives.

The view is generally held that the explosion was due to spontaneous combustion of grain dusts and it is also believed that a highly explosive mixture of humid air and grain dust was ignited by a spark possibly from a watchman's cigarette. There could have been no sparks from the machinery, because the explosion occurred at night when machinery was idle.

There were two distinct explosions. The first was a small one, evidently in the driers. This merely acted as an igniter, or detonator, of the main explosion, which passed like a wave of fire through the entire structure. It was announced by the Illinois State fire marshal that complete investigation will be made into the cause of this explosion.

### Bureau of Mines May Study Black Hills Ores

A study of the complex sulphides, argentiferous galena in quartz and the blue ores containing gold in sulphides, occurring in the Black Hills region, may be undertaken by the Bureau of Mines under a co-operative agreement with the mining and business interests of that section. There is said to be a large tonnage of refractory ores in the Black Hills which could be mined if improved processes were devised.

### Colloidal Clay as Paper Filler

A highly colloidal clay, found in the Rocky Mountain region, has been found by the Forest Products Laboratory at Madison, Wis., to be highly valuable as a loading material for paper. This clay when added to English china clay is said to produce a superior finish and a more velvety quality than when the English clay is used alone.

### Stolen Platinum Recovered

The police in Washington report the recovery of the platinum stolen from the Bureau of Standards more than a year ago. A former employee of the bureau was arrested on another charge. A subsequent search of his home led to the discovery of the platinum buried in the cellar.

### Chemical Warfare Association Proposed

Plans are being made for the formation of an organization which probably will be known as the Chemical Warfare Service Association. The idea is to take organized steps to acquaint the public with the need for continuing active research and development along the line now being followed. The association would use its influence to secure an adequate proportion of the War Department's appropriations for the Chemical Warfare Service. It would endeavor to co-ordinate the experimentation of this character being done by the Army and by the Navy. The broad thought is to work in the interest of this service, which many believe to embody a more efficient and humane method of warfare and one which gives great advantage to an industrial nation.

The final decision in the matter probably will be reached at the third annual dinner of the Chemical Warfare Service, which will be held in Washington the middle of April.

## Book Reviews

**CHRONOLOGY OF IRON AND STEEL.** Compiled by S. L. Goodale, Professor of Metallurgy, University of Pittsburgh, and edited by J. R. Speer, chairman of the Board, Pittsburgh Iron & Steel Foundries Co. Published by the Pittsburgh Iron & Steel Foundries Co., Pittsburgh, Pa. Price, \$5.

This little book of pocket manual size (4 in. x 6½ in.) contains 300 pages of brief notes on the discovery, development, and perfection of iron and steel making and many related occurrences. Starting with the birth of Tubal-cain, "the forger of every cutting instrument of brass and iron," and ending with the death of Andrew Carnegie and Henry C. Frick, men of steel and coke, it mentions a great many names of men of various attainments who have lent their aid in perfecting this most useful aid to civilization, as well as many events in the passing years which resulted not so much from one individual's effort as from the march of events.

All the incidents are arranged according to the approximate date of occurrence. Lacking this information as a starting point, one may consult an alphabetical index at the end.

The compilation is evidently very carefully done, and the book contains a great amount of information which will attract those who are interested in knowing something of the "family tree" of familiar articles made of iron and steel.

E. E. THUM.

**CHEMISTRY OF PULP AND PAPER MAKING.** By Edwin Sutermeister, chief chemist, S. D. Warren Co. Paper Mills. vii + 479 pp.; 55 figs.; 31 full-page photomicrographs. Price \$6 (33s.). New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd. 1920.

It is over twenty-five years since Griffin and Little published their "Chemistry of Paper Making." During that time there have been very notable advances in both the pulp and paper industries. The paper industry will, therefore, welcome the contributions of 1920, which include Witham's "Modern Pulp and Paper Making," which deals with the technical and mechanical sides of the industry, and Sutermeister's "Chemistry of Pulp and Paper Making," dealing primarily with the chemical aspects of the industry. The material covered by Sutermeister's book is best seen from the following list of chapter titles: Cellulose; fibrous raw materials: rags, esparto, straw, bamboo; the soda process; the sulphate process; the sulphite process; ground wood or mechanical pulp; bleaching, sizing, loading and filling materials; coloring; coated papers; water; testing wood pulps; paper testing; printing. The author has included all details which the chemist should have to enable him to grasp the methods of manufacture, but the book is in no way a treatise on the manufacturing details of the industry. The work is "written chiefly with the idea of



helping the young technical man, whether chemist or engineer, and it has therefore been assumed that the reader has a fair knowledge of the elements of chemistry."

Sutermeister is particularly well qualified to write such a treatise, since he has been engaged in the paper industry for twenty years, and he has combined the experiences of these years with a careful review of the literature. The industry is peculiar in that there are an unusually large number of variable factors which influence any one operation; it is not surprising, therefore, that the literature should be full of conflicting statements and opinions. In some cases an attempt has been made to reconcile these statements; in other cases both sides of the argument have been presented as fairly as possible. The reader will, therefore, find many lines of investigation indicated throughout the book. Thus in the chapter on bleaching the following are some of the problems indicated: "The conclusion that slight washing is not likely to prove injurious to the durability of the paper is counter to the generally accepted theories, but from the above experiment (p. 247) no other conclusion can be reached." "The folding and bursting strength of sulphate is not injured by bleaching . . ." Under the chapter on rosin the question is again raised regarding the use of so-called wood rosin in paper sizing. This apparently is not an entirely reliable method, but more conclusive tests should be carried out. Another question on sizing is the relation between the manner of drying and the sizing of the sheet. These are only a few of the many research problems that the paper maker will find as he carefully reads the book.

The book is well written and illustrated, and is well executed mechanically. The photomicrographs of the typical paper-making fibers and of the loading and filling materials, prepared by the Bureau of Standards, add much to the value and appearance of the work.

The pulp and paper industry is to be congratulated on this addition to an altogether too scanty scientific literature of the art.

CLARENCE JAY WEST.

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## Personal

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Dr. E. Q. ADAMS, of the staff of the Bureau of Chemistry, has tendered his resignation and will take a position in the Nela laboratory of the National Lamp Works at Cleveland.

H. A. BERG, superintendent of blast furnace operations of the Midvale Steel & Ordnance Co. at Johnstown, Pa., has been appointed to succeed W. A. Maxwell, Jr., as assistant general superintendent of the Cambria Steel Co., Johnstown, Pa., the latter having resigned to accept the position of general superintendent of the Inland Steel Co., Indiana Harbor, Ind.

Dr. HENRY C. BOYNTON, metallurgist at the plant of the John A. Roebling's Sons Co., Trenton, N. J., gave an interesting address recently before the members of the local Rotary Club on the subject of the "Evolution of Wire Rope." The talk was illustrated with lantern slides.

R. B. BROWN, superintendent of the Chicago plant of the Sherwin-Williams Co., spoke before the Chicago Chemists Club recently, on the application of chemistry to paint and varnish industries.

A. E. DRUCKER, professor of metallurgical engineering at the Wisconsin School of Mines, went to the University of Illinois Feb. 1 as assistant professor of mining engineering.

Dr. GUSTAV EGLOFF was in New York for a few days last week.

F. C. FAIR has been placed in charge of the new chemical laboratory established by the Railway Signal Co., Hammond, Ind. This company has headquarters at Pittsburgh and manufactures fuses and torpedos for signaling on railroads.

WALTER J. GELDARD recently resigned as chief of the analytical section, Fixed Nitrogen Research Laboratory, and

has accepted a similar position with the International Coal Products Corporation of Newark, N. J.

WALTER F. GRAHAM has resigned as metallurgist with the Spicer Manufacturing Co., Plainfield, N. J., and is now associated with the Henry Souther Engineering Co., Hartford, Conn. Mr. Graham was formerly associated with the late Henry Souther as metallurgist for the Standard Roller Bearing Co., and subsequently with the Ferro Machine & Foundry Co. and the Ingersoll-Rand Co.

CHARLES HORVATH, research chemist for the International Motor Co., New Brunswick, N. J., resigned some months ago to become chief chemist for the National Metal Reduction Co., Newark, N. J., and the Atlantic Smelting & Refining Works of New York City, the plants of which are located in Newark.

J. C. INGRAM, who has for the past four years been chemical engineer in charge of the refinery, oil and soap division for the American Cotton Oil Co., Chicago, has resigned to accept a position as development engineer with Morris & Co. Mr. Ingram's activities will have to do with developing production problems through scientific application at the Chicago packing plant.

H. E. LABOUR, until recently president of the Chemical Equipment Co., has severed his connection, effective March 15, and will remain in Chicago, opening a consulting and sales office.

Major J. C. MILLS has joined the staff of the Chemical Warfare Service as chief chemical adviser to General Fries. During the war Major Mills went to France with the first gas regiment. He was one of the mainstays of the service throughout the struggle. To accept his present position, Major Mills retired from the faculty of the University of North Carolina.

Dr. R. B. MOORE, the chief chemist of the Bureau of Mines, will address the New York Section of the American Electrochemical Society on April 8. In view of the forthcoming visit of Mme. Marie Curie, he has chosen radium as his subject.

A. V. H. MORY, who has recently severed connections with Procter & Gamble Co., Cincinnati, Ohio, is associated with William Hoskins at 111 W. Monroe St., Chicago, on consulting work.

Dr. H. T. NIXON, formerly chief chemist at the Argentine refinery of the Sinclair Refining Co., recently resigned to become chief chemist for the C & C Developing Co., Kansas City, Mo., which concern applied the Cherry process for producing synthetic gasoline.

Dr. ARNOLD H. SMITH resigned his position as research chemist with the Goodyear Tire & Rubber Co., to assume the position of chief chemist with the Thermoid Rubber Co., Trenton, N. J.

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## Obituary

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JAMES B. BROAD, Wilmington, Del., comptroller for E. I. du Pont de Nemours & Co., died March 13, at the Homoeopathic Hospital from lung infection, caused by swallowing a tooth during a dental operation. He was forty-three years of age and had been connected with the company in various capacities since 1904. He became comptroller in 1918.

Dr. FRANK W. GUNSAULUS, president of Armour Institute, died March 17 at the age of sixty-five. He was stricken suddenly with heart disease and passed away two hours afterward at his home, 2919 Prairie Ave., Chicago, Ill.

JACOB HASSLACHER, founder of the firm of Roessler & Hasslacher, died on March 15 at his home in New York City. Born at Ems-am-Lahn, Germany, in 1852, he came to New York in 1884, and within five years started a most successful and influential career. Mr. Hasslacher leaves a widow, Mrs. Elizabeth Fleck Hasslacher; two sons, George and Carl, and four daughters, Misses Agnes, Toni, Thea and Emily.

## Current Market Reports

### The Chemical and Allied Industrial Markets

NEW YORK, March 28, 1921.

There was no particularly marked improvement in the demand for chemicals during the past week. Intervals of buying have been followed by periods of extreme dullness; nevertheless, business in general is a shade better compared with the past few weeks. Expansion promises to be slow but steady and there is little in the present situation to inspire any strong optimistic tendencies. Perhaps it is better that it is so as there will be fewer vain regrets arising from the danger of an overextension of trade expansion. There were persistent reports from several directions of curtailed chemical production, while in some cases production has been temporarily suspended, as there is enough stock in second hands to take care of the demand at lower prices than producers can name. This condition is true among leading manufacturers of caustic soda. It is generally agreed that the peak of depression has passed, but how soon business will pick up is a problem only time can solve. Reductions in overhead and operating expenses are being made quite generally and seem to be working temporary hardships in many cases, but in the long run are expected to bring lower prices and normal conditions.

#### OTHER MARKETS STAGNANT

In trying to analyze the chemical market, it is well to look into other markets, as conditions are practically similar and a great deal rests upon the materialization of developments there. The primary and wholesale markets, which for a time have shown a spotty improvement, have in many cases become dormant again. Railway traffic and earnings are decreasing continually. Steel output has fallen to less than one-half of mill capacity. Production of coal has fallen to the lowest point in the past few years and building operations are lagging far behind the total of new construction known to be in immediate demand. Moderate liquidation from the reserve banks is reflected in the slight improvement in the reserve ratio of the federal reserve system, although a substantial part of this improvement is the result of gold importations which have continued uninterruptedly for the past year. Buyers as a result of existing conditions remain unwilling to contract for other than immediate necessities, which are at an extremely low figure.

The passing of the payment of the income tax for 1920 was a favorable feature. This had an unusually quieting effect on the chemical trade, but business seemed to become brisk again shortly after. The disposition on the part of some interests to sell English soda ash at \$1.90 per 100 lb. ex dock N. Y. is being watched very cautiously. Caustic soda held well owing to the suspension of production and consuming orders came into the market in better volume than in the past month. Business has been placed with a few textile and soap plants.

Reports from various quarters in the New England States show that textile mills are averaging about 70 per cent normal output. Some plants are operating at full capacity, while others have found the road harder to travel on account of the keen competition and have been unable to accomplish much more than one-half their total capacity production. With fall prices completed, the woolen industry seems to have improved and several American Woolen Co. plants have resumed operation on full-time schedule. Reductions in wages and lower prices for finished products are the principal factors responsible for the noticeable improvement among these mills. Reports from leading Western chemical producers were more optimistic than from local points.

Standard brands of *caustic soda* appear to be well held at the present time. Buyers demanding special makes are finding a stiff market. The general range was from \$3.70 @ \$3.80 per 100 lb. ex-warehouse and \$3.80 @ \$3.85 f.a.s.

Occasionally arrivals from interior points go at a slight concession, while outside makes can be purchased in the neighborhood of 3½c. per lb. Resale light *soda ash* is generally quoted at \$1.95 @ \$2.05 per lb. in single bags. Offerings of English material have left the market in a somewhat unsettled condition. The feeling is prevalent in the trade that producers will be forced to meet foreign competition, but as yet they have failed to do so. Barrels are quoted from \$2.10 @ \$2.25 per 100 lb., according to quantity. Contract prices remain unchanged at \$1.72½ per 100 lb., basis 48 per cent, in carlots f.o.b. works.

Imported 88-92 per cent *caustic potash* is offered at 10c. per lb. with odd lot sales noted down to 9½c. per lb. A peculiar position exists in this market due to the fact that the 70-75 per cent KOH is selling at a higher figure than the stronger variety. Exporters bought the 88-92 per cent almost exclusively during the past year and with the recent slump in the foreign markets all this material was reshipped to American ports and dumped into the market. Leading factors in *chlorate of potash* are asking 10 @ 12c. per lb. for prime American material. It is stated that a cheap lot of imported stock has been taken off the market. There are enough stray lots, however, that still can be purchased all the way down to 8c. per lb. The better grades of imported material are offered at 9 @ 10c. per lb. Small quantities of *yellow prussiate of potash* are being offered by dealers at 25 @ 27c. per lb. The red variety is in small supply, with the market quoted around 50c. per lb. Fused 60-62 per cent *sodium sulphide* is quoted at 5½ @ 5¾c. per lb. by second hands. The crystals, 30 per cent, are very scarce at present and buyers are finding difficulty in covering requirements of spot material. Spot *citric acid* is quoted firm, with sales at 47c. per lb. and sellers asking up to 48c. Continued strength prevails in the foreign market and 42c. per lb. for shipment from abroad is considered a very close figure. Some real business has recently been placed at these levels and the market for the coming season looks exceptionally favorable for early buying at the low prices.

A continued quiet inquiry for *bichromate of soda* has had a depressing influence on spot quotations during the past week and the market closed easy with a moderate amount of resale material of standard quality offered at 7½c. per lb. The range was from 7½ @ 7¾c. per lb., according to quantity. While resale stocks are not described as heavy, it is asserted that unless the demand improves a lower trading is likely to be established. Prices on *ammonium chloride* continued rather uncertain in the absence of any noted demand. Imported material is still to be had in good volume at prices well below those named by domestic producers. White granulated *sal ammoniac*, imported, is offered at 7½ @ 8c. per lb., with domestic prices around 10c. The gray variety is to be had at 8 @ 9c. per lb. A continued lack of interest has forced further recessions on *ammonium sulphate* and offers are now heard at \$2.75 @ \$2.85 per 100 lb. in single bags. Double bags for export are quoted down to 3c. per lb. Leading makers of *calcium acetate* are quoting on the former basis of \$2 per 100 lb., but there are offers in the market from outside manufacturers as low as \$1.50 per 100 lb. The weakness of acetic acid has prevented strength in this item.

According to figures on foreign trade recently issued by the Department of Commerce, increased imports and decreased exports in February as compared with January are shown in the following table:

	February, 1921	January, 1921
Exports .....	\$489,000,000	\$655,000,000
Imports .....	215,000,000	209,000,000
Totals .....	\$274,000,000	\$446,000,000
	February, 1920	January, 1920
Exports .....	\$5,127,000,000	\$5,230,000,000
Imports .....	2,757,000,000	3,235,000,000
Totals .....	\$2,370,000,000	\$1,995,000,000

#### COAL-TAR PRODUCTS

Although there was a difference of opinion expressed in various quarters on the action of the coal-tar products market, there surely was an expansion noted on the part of consumers and also on the volume of trading. Sales were confined to limited quantities, as the future needs are not being anticipated.



Intermediates have shown very little change during the week and while most producers have held quite close to last week's prices, there has been a tendency toward shading on firm business. There still seems to be quite a few resale lots of intermediates offered on the market, but the prices at which they were quoted did not reveal any marked concessions under prevailing levels. A fair volume of inquiries was noted, on the other hand, and in view of the fact that plants are producing on a smaller scale a scarcity of some commodities will eventually show on the market.

The crude market held steady and prices have practically shown no noticeable change, except in naphthalene flakes and balls, which are a trifle firmer in view of the more active demand at this time of the year.

Supplies of *diethylaniline* are available in fair volume in some directions. There has been very little interest shown by consumers, other than a quiet routine movement of small quantities. Prices ranged from \$1.25@1.30 per lb. The demand for *alpha naphthol* during the week has been very light and while the level of prices holds fairly steady for the crude at \$1.20 per lb, shading is possible in second hands at \$1.10@1.15. The position of *beta naphthol* seemed to be a trifle weaker, although quite a few factors claimed a better demand. First hands are firm in their views and quote the market at 40@43c. per lb. Resale material is available in fair volume down to 33c. per lb. Resale offerings of *paranitraniline* continue around 85c. per lb., but producers are still unwilling to sell below 95c.@1.05 per lb. for spot or prompt shipment. Makers are rather inclined to doubt the quality of resale material which has been out of their hands for some time. Contracts are offered by manufacturers at \$1.15 per lb., although shading is quite possible on firm business.

### The Chicago Market

CHICAGO, March 25, 1921.

Quiet conditions still prevail in the market for industrial chemicals. Reports from some quarters indicate that a fair volume of business is being done, although only in small packages. Consumers are still adverse to anticipate and are buying only for their immediate requirements.

*Soda ash*, 58 per cent, continues to be firm and is quoted in barrels at \$3.10 per 100 lb. for small quantities. *Caustic soda*, 76 per cent, is quoted as high as \$4.25 per 100 lb. in ton lots. *Salsoda* is moving in a small way at 2½c. per lb. *Bleaching powder* is very dull, and is quoted at 3½c. in 700-lb. drums.

Producers' agents are offering *formaldehyde* at 16½c. and are doing considerable business at this figure. Most of the resale material is now out of the market and the first hands are again able to compete. Spot *potassium chlorate* crystals are available at 13c., but most factors report little business. *Caustic potash*, 88-92 per cent, is quoted in 700-lb. drums at 11½c., but with actual business in sight this could probably be bettered. *Potassium carbonate*, 80-85 per cent, is offered at 15½c. in casks. *Glycerine*, c.p., is lower and refiners now quote 18c. per lb. in drums. The new level for non-beverage *ethyl alcohol* is \$4.85 per gal. in single drums, and is moving in a fair way. The continued mild winter has had its effect on the *denatured alcohol* market, distillers quoting 40c. per gal. in five-drum lots on the 188 deg. proof completely denatured, while a wide range of prices can be obtained from resellers. *Wood alcohol*, 95 per cent, continues weak, and is quoted at 85c. in barrels, or 77c. in drums.

*Quicksilver* is very quiet and is quoted from \$48@52 per flask. *Ammonia*, 26 deg., is available at 7½c. in drums. White granular *ammonium chloride* is offered at 11½c. in single barrels, but very little is moving. Imported *barium chloride* is offered at \$80 per ton in cask lots. Some interests report a fair volume of small business in *lead acetate*, white crystal, at 15c. per lb. Spot *sodium dichromate* can be had at 9½c., with somewhat better prices on material for prompt shipment from the works. *Potassium dichromate* is offered to arrive at 16c., but it is doubtful if much business could be done at this figure.

The general list of acids is firm and quiet, with the exception of *acetic acid*. The *glacial* is now offered by makers at \$11.25 per 100 lb. in lots of fifteen to twenty barrels.

The 28 per cent is moving in a very fair way at 2½c. in barrels and 3½c. in carboys. *Muriatic acid*, 18 deg., is offered at from 1¼@2½c., depending upon the quantity. *Sulphuric acid*, 66 deg., is quoted around \$20 per ton, but, like the rest of the list, is very quiet. *Oleum* can be had for \$3.10 per 100 lb. in drums. Imported *oxalic acid* is offered on spot at 19½c. in single casks, while producers continue to quote 25c. for the domestic.

### VEGETABLE OILS

The vegetable oil market is extremely quiet and business in most of the oils is confined to unusually small parcels. The trade appears to have adopted a waiting policy and buyers are holding off pending developments in the general situation. *Coconut oil* is quoted at 10½c., but very little is moving. *Linseed oil* is offered at 69c. in single barrels, but, owing to the quietness in the paint trade, very little is being sold.

### NAVAL STORES

Conditions in the local naval stores trade have undergone little change and a quiet tone was reported in all quarters. *Turpentine* is quoted at 58c. in drums, the demand being light. *Rosin* is offered at \$7.35 for the WG with corresponding prices for the other grades.

### COAL-TAR PRODUCTS

Business in coal-tar products is still very dull, although encouraging reports are heard in some quarters. There is an ample supply of *benzene* available at 31c. per gal. for the 90 per cent and 33c. for the 100 per cent in lots of one to ten drums. Refined *toluol* can be obtained for 33c. per gal. There is little demand for *naphthalene flakes*, which are being held on spot for 10½c. in small lots.

### The Iron and Steel Market

PITTSBURGH, March 25, 1921.

The slight improvement in demand for steel products noted a week ago has grown. There is distinctly noticeable a greater call for steel products, particularly for merchant bars, standard steel pipe and sheets. The week's news of structural work shows a larger tonnage, but this may prove ephemeral. In the other products mentioned the call is widespread, there being numerous small lots.

Careful scrutiny does not indicate that the increased call for steel is a seasonal affair, due to the arrival of spring. Rather it is due to the technical condition of the trade, there having been for weeks a particularly rigid curtailment by all buyers, while they reduced inventories. Such an extreme lightness of demand could not continue indefinitely, as it was far below the rate of actual consumption.

The total of demand now, however, is still small. There is merely improvement in the rate. Absolutely fresh buying remains very light, the improvement in the call for material being chiefly by way of releases on orders, shipment against which had been held up. The rate of production of steel continues to decline, shipments having been in excess of specifications and orders, and a further decline in production is to be expected in the next few weeks, until demand increases sufficiently to effect a turn.

The United States Steel Corporation's production last week, measured by ingots, was about 49 per cent of capacity. This week production is slightly less, probably about 45 per cent. The common estimate now is that the independents are operating at 20 per cent or less. These percentages would make rates of production of 10,000,000 tons of ingots a year by the Steel Corporation and 6,000,000 tons by the independents, the 16,000,000 tons being 30 per cent of the present estimate of capacity or 53 per cent of the average rate in 1912 and 1913, the two best tonnage years before the war, when there appeared to be a widespread demand for steel products for practically all employments. Now there appears to be scarcely any consumption, and from this viewpoint the actual production is high rather than low.

### PRICES

On carload lots with fairly desirable specifications bars are still quotable at 2c. and shapes and plates at 2.10c. Concessions possible from these figures for really large lots

are if anything smaller than obtainable a month ago. Black sheets remain at 3.85c. for carload lots with desirable specifications. Galvanized sheets in carload lots may be quoted at 4.90c., or \$2 a ton less than a week ago. The spread of 1.05c. between black and galvanized is equal to the average spread in the ten years before the war. Zinc is considerably lower, while wages are higher.

#### STANDARD STEEL PIPE LOWER

Standard steel pipe has now joined the list of steel products on which Industrial Board or Steel Corporation prices are shaded. Several independent mills now quote an extra 2½ per cent in addition to the customary trimmings from the published list, which has a basing discount of 5½ per cent. It is reported that in some cases an extra 5 per cent is given, the extra discounts representing approximately \$2 and \$4 a ton respectively from the prices hitherto held. It is reported that several mills have put out a price guarantee.

Tin plate is now the only important steel product in the independent market remaining at the Steel Corporation or Industrial Board price. Tin plate is held at the \$7 price chiefly perhaps because mills recognize that if cutting once began it could not be stopped.

#### STEEL CORPORATION POSITION

The wisdom of the Steel Corporation's continued policy of maintaining its prices is being more generally commended. It is plainly seen that price reductions do not bring out additional business, that consumers do not wish to make commitments at this time, and that indeed many buyers prefer to see prices maintained, as facilitating their disposal of material already on hand. That the Steel Corporation will eventually reduce its prices, and will reduce them quite sharply, is commonly believed. Opinion differs as to whether the corporation will reduce prices first and wages afterward or will act on both subjects at the same time. It seems improbable that the corporation will maintain present prices and wages longer than until May 1.

#### PIG IRON

Sufficient movement of basic pig iron out of stocks of steel interests has occurred to force recognition of the steel works as making the pig iron market. Steel interests have sold basic at \$23 valley, and are willing, even anxious, to sell more at the same price. The merchant furnaces continue to quote their former price of \$25, which is below their recent or even present cost of production, including overhead, but the steel interests can probably figure that iron sold at \$23 can later be replaced at a lower cost, without allowance for overhead. Bessemer remains quotable nominally at \$27 valley, but it is understood that it has been offered in limited quantities by dealers at \$25. Foundry iron, recently quotable at \$26 valley, can now be had at \$25.

#### SEMI-FINISHED STEEL

There are dilettante negotiations between sheet mills and steel mills on sheet bars. The sheet mills do not make bids, and do not close when offered sheet bars at \$38. Standard billets are nominally at the same price as sheet bars. Small billets have been quoted at \$40.

#### STEEL PROSPECTS

The volume of demand for steel in the next few months is regarded as hingeing chiefly upon two factors, the matter of German reparations and the attitude of labor in the building trades. Settlement of the reparations question would greatly improve general sentiment and would probably stimulate business to an extent. Reductions in the wage scales of the building trades would in all probability materially stimulate building, which is now at a low ebb. That any very large tonnage demand for steel would be created by a wave of dwelling house construction is obviously improbable. The large consumption of steel lies rather in hotel and skyscraper buildings and in power development. The oil country demand for tubular goods may easily revive. Oil prices are down, but if the cost of drilling is correspondingly reduced the oil industry will be more promising than in 1920.

### General Chemicals

#### CURRENT WHOLESALE PRICES IN NEW YORK MARKET

	Carlots	Less Carlots
Acetic anhydride.....lb.		\$0.40 - \$0.45
Acetone.....lb.	\$0.13 - \$0.13½	.13½ - .14
Acid, acetic, 28 per cent.....100 lbs.	2.50 - 2.75	3.00 - 3.25
Acetic, 56 per cent.....100 lbs.	4.00 - 4.25	4.50 - 5.50
Acetic, glacial, 99½ per cent, carboys.....100 lbs.	9.00 - 9.50	10.00 - 10.50
Boric, crystals.....lb.	.14½ - .15	.15½ - .16
Boric, powder.....lb.	.15½ - .16½	.17 - .18
Citric.....lb.		.47 - .50
Hydrochloric.....100 lb.	1.75 - 2.00	2.10 - 2.25
Hydrofluoric, 52 per cent.....lb.	.13 - .13½	.14 - .14½
Lactic, 44 per cent tech.....lb.	.10 - .11	.11½ - .12
Lactic, 22 per cent tech.....lb.	.04½ - .05½	.06 - .07
Molybdic, C. P.....lb.	4.00 - 4.50	4.50 - 5.00
Muriatic, 20 deg. (see hydrochloric).....lb.	.06½ - .07	.07½ - .07½
Nitric, 40 deg.....lb.	.07½ - .08	.08½ - .08½
Nitric, 42 deg.....lb.	.16½ - .17	.17½ - .18
Oxalic, crystals.....lb.	.15 - .15½	.16 - .16½
Phosphoric, Ortho, 50 per cent solution.....lb.	.30 - .32	.35 - .40
Picric.....lb.		1.90 - 2.15
Pyrogallol, resublimed.....lb.		
Sulphuric, 60 deg., tank cars.....ton		15.00 - 16.00
Sulphuric, 60 deg., drums.....ton	19.00 - 20.00	
Sulphuric, 66 deg., tank cars.....ton	22.00 - 22.50	23.00 - 23.50
Sulphuric, 66 deg., drums.....ton		
Sulphuric, 66 deg., carboys.....ton		
Sulphuric, fuming, 20 per cent (oleum) tank cars.....ton	23.00 - 24.00	
Sulphuric, fuming, 20 per cent (oleum) drums.....ton	25.00 - 26.00	26.50 - 27.00
Sulphuric, fuming, 20 per cent (oleum) carboys.....ton	32.00 - 35.00	40.00 - 41.25
Tannic, U. S. P.....lb.		.48 - .50
Tannic (tech.).....lb.	.45 - .47	.36 - .40
Tartaric, crystals.....lb.		1.30 - 1.40
Tungstic, per lb. of WO.....lb.		4.90 - 5.25
Alcohol, Ethyl.....gal.		.40 - .45
Alcohol, Methyl (see methanol).....gal.		.50 - .54
Alcohol, denatured, 188 proof.....gal.		.04½ - .05
Alcohol, denatured, 190 proof.....gal.		.06½ - .07
Alum, ammonia lump.....lb.	.05½ - .06	.14 - .14½
Alum, potash lump.....lb.	.13 - .13½	.02½ - .03
Alum, chrome lump.....lb.	.02½ - .03	.03½ - .03½
Aluminum sulphate, commercial.....lb.	.03 - .03½	.07½ - .08
Aluminum sulphate, iron free.....lb.	.03 - .03½	.33 - .35
Aqua ammonia, 26 deg., drums (750 lb.).....lb.	.30 - .32	.11½ - .12
Ammonia, anhydrous, cyl. (100-150 lb.).....lb.	.10 - .11	
Ammonium carbonate, powder.....lb.		.08 - .08½
Ammonium chloride, granular (white sal-ammoniac) (nominal).....lb.	.07½ - .07½	.09 - .09½
Ammonium chloride, granular (gray sal-ammoniac).....lb.	.08 - .08½	.09 - .09½
Ammonium nitrate.....lb.	.08 - .08½	3.10 - 3.20
Ammonium sulphate.....100 lb.	2.90 - 3.00	4.00 - 4.25
Amylacetate.....gal.		3.25 - 3.50
Amylacetate tech.....gal.		.09 - .10
Arsenic oxide, (white arsenic) powdered lb.....lb.	.08 - .08½	.13 - .14
Arsenic, sulphide, powdered (red arsenic) lb.....lb.	.12 - .12½	75.00 - 80.00
Barium chloride.....ton	65.00 - 70.00	.21 - .22
Barium dioxide (peroxide).....lb.	.19 - .20	.10½ - .11
Barium nitrate.....lb.	.10 - .10½	.05½ - .06
Barium sulphate (precip.) (blanc fixe).....lb.	.04½ - .05	
Bleaching powder (see calc. hypochlorite).....lb.		
Blue vitriol (see copper sulphate).....lb.		
Borax (see sodium borate).....lb.		
Brimstone (see sulphur, roll).....lb.		.42 - .45
Bromine.....lb.	.40 - .41	.04½ - .05
Calcium acetate.....100 lbs.	1.60 - 2.00	.02 - .02½
Calcium carbide.....lb.	.04 - .04½	.15 - .16
Calcium chloride, fused, lump.....ton	27.00 - 29.00	1.25 - 1.50
Calcium chloride, granulated.....lb.	.01½ - .01½	.03 - .03½
Calcium hypochlorite (bleach'g powder) lb.....lb.	.02½ - .02½	.07 - .07½
Calcium peroxide.....lb.		.09 - .09½
Calcium phosphate, tribasic.....lb.		.11 - .12
Camphor.....lb.		.70 - .75
Carbon bisulphide.....lb.	.08 - .08½	.75 - 1.00
Carbon tetrachloride, drums.....lb.	.10 - .10½	
Carbonyl chloride (phosgene).....lb.		
Caustic potash (see potassium hydroxide).....lb.		
Caustic soda (see sodium hydroxide).....lb.		.09½ - .10
Chlorine, gas, liquid-cylinders (100 lb.).....lb.	.08 - .09	.38 - .40
Chloroform.....lb.		3.00 - 3.10
Cobalt oxide.....lb.		
Copperas (see iron sulphate).....lb.		.24 - .25
Copper carbonate, green precipitate.....lb.	.22 - .23	.55 - .63
Copper cyanide.....lb.		.05½ - .06½
Copper sulphate, crystals.....lb.	.05½ - .05½	
Cream of tartar (see potassium bitartrate).....lb.		
Epsom salt (see magnesium sulphate).....lb.		.90 - 1.00
Ethyl Acetate Com. 85%.....gal.		
Ethyl Acetate pure (acetic ether 98% to 100%).....gal.		
Formaldehyde, 40 per cent.....lb.	.15½ - .16	.16 - .16½
Fusel oil, ref.....gal.		3.50 - 3.75
Fusel oil, crude.....gal.		2.00 - 2.25
Glauber's salt (see sodium sulphate).....lb.		.18 - .19
Glycerine, C. P. drums extra.....lb.		3.75 - 3.85
Iodine, resublimed.....lb.		.10 - .20
Iron oxide, red.....lb.		.13½ - .14½
Iron sulphate (copperas).....100 lb.	1.05 - 1.10	.12 - .13
Lead acetate.....lb.		.15 - .20
Lead arsenate.....lb.	.11 - .12	.09½ - .10
Lead nitrate.....lb.		1.25 - 1.50
Litharge.....lb.	.08½ - .09	.11½ - .12
Lithium carbonate, technical.....lb.	.10½ - .11	2.25 - 2.50
Magnesium carbonate, technical.....lb.	2.75 - 3.00	.75 - .77
Magnesium sulphate, U. S. P.....100 lb.		.78 - .82
Magnesium sulphate, commercial.....100 lb.		.12 - .13
Methanol, 95%.....gal.		.45 - .46
Methanol, 97%.....gal.		.35 - .37
Nickel salt, double.....lb.		.13½ - .14
Nickel salt, single.....lb.		
Phosgene (see carbonyl chloride).....lb.		
Phosphorus, red.....lb.	.45 - .46	
Phosphorus, yellow.....lb.		
Potassium bichromate.....lb.	.12 - .13	



	Carlots	Less Carlots
Potassium bitartrate (cream of tartar)..... lb.	\$ 30 - \$ 35	\$ 30 - \$ 35
Potassium bromide, granular..... lb.	20 - 40	20 - 40
Potassium carbonate, U. S. P..... lb.	35 - 40	45 - 50
Potassium carbonate, crude..... lb.	08 - 08 1/2	09 - 10
Potassium chlorate, crystals..... lb.	08 - 10	11 - 15
Potassium cyanide..... lb.	09 1/2 - 10	40 - 45
Potassium hydroxide (caustic potash)..... lb.	60 00 - 70 00	10 1/2 - 11 1/2
Potassium iodide..... lb.	09 1/2 - 09 1/2	2 75 - 3 00
Potassium nitrate..... lb.	45 - 46	10 - 12 1/2
Potassium permanganate..... lb.	50 - 52	48 - 50 1/2
Potassium prussiate, red..... lb.	25 - 26	53 - 55
Potassium prussiate, yellow..... lb.		27 - 28
Potassium sulphate (powdered)..... per unit		2 15 - 2 25
Rochelle salts (see sodium potas. tartrate).....		
Salammoniac (see ammonium chloride).....		
Salt soda (see sodium carbonate).....		
Salt cake..... ton	32 00 - 34 00	
Silver cyanide..... oz.	1 30 - 1 35	
Silver nitrate..... oz.	38 - 40	
Soda ash, light..... 100 lb.	1 95 - 2 10	2 15 - 2 40
Soda ash, dense..... 100 lb.	2 20 - 2 30	2 40 - 2 60
Sodium acetate..... lb.	05 1/2 - 05 1/2	06 - 06 1/2
Sodium bicarbonate..... 100 lb.	2 60 - 2 75	3 00 - 3 25
Sodium bichromate..... lb.	07 1/2 - 07 1/2	07 1/2 - 08
Sodium bisulphate (nitre cake)..... ton	6 00 - 6 25	7 00 - 8 00
Sodium bisulphate powdered, U.S.P..... lb.	05 1/2 - 05 1/2	06 - 06 1/2
Sodium borate (borax)..... lb.	07 1/2 - 08	08 1/2 - 08 1/2
Sodium carbonate (sal soda)..... 100 lb.	1 90 - 2 00	2 25 - 2 50
Sodium chlorate..... lb.	10 - 10 1/2	10 1/2 - 11
Sodium cyanide, 96-98 per cent..... lb.	18 - 20	22 - 30
Sodium fluoride..... lb.	12 - 12 1/2	13 - 14
Sodium hydroxide (caustic soda)..... 100 lb.	3 60 - 3 70	3 80 - 4 00
Sodium hyposulphite..... lb.	2 75 - 2 85	03 1/2 - 04
Sodium nitrate..... 100 lb.	06 - 06 1/2	06 1/2 - 07
Sodium nitrite..... lb.	30 - 31	32 - 34
Sodium peroxide, powdered..... lb.	04 1/2 - 04 1/2	05 - 05 1/2
Sodium phosphate, dibasic..... lb.	07 - 07 1/2	07 1/2 - 08
Sodium potassium tartrate (Rochelle salts)..... lb.	13 - 13 1/2	13 1/2 - 14
Sodium prussiate, yellow..... lb.	1 25 - 1 35	1 40 - 1 50
Sodium silicate, solution (40 deg.)..... lb.	03 - 03 1/2	03 1/2 - 03 1/2
Sodium silicate, solution (60 deg.)..... lb.	1 75 - 2 00	2 25 - 2 50
Sodium sulphate, crystals (Glauber's salt) 100 lbs.	05 1/2 - 05 1/2	05 1/2 - 06
Sodium sulphate, crystals, 60-62 per cent (conc.) lb.	04 - 04 1/2	04 1/2 - 05
Sodium sulphate, crystals..... lb.	15 - 15 1/2	16 - 17
Sodium sulphate, powdered..... lb.	07 - 07 1/2	07 1/2 - 08
Sulphur chloride, red..... ton	18 00 - 20 00	09 - 10
Sulphur dioxide, liquid, cylinders..... 100 lb.	08 - 08 1/2	2 25 - 3 10
Sulphur (sublimed), flour..... 100 lb.		2 00 - 2 75
Sulphur, roll (brimstone)..... 100 lb.		
Tin bichloride, 50 per cent..... lb.	18 - 19	40 - 42
Tin oxide..... lb.	16 - 18	19 - 20
Zinc carbonate, precipitate..... lb.	11 - 11 1/2	11 1/2 - 12
Zinc chloride, gran..... lb.	45 - 49	50 - 60
Zinc cyanide..... lb.	12 - 13	13 1/2 - 14
Zinc dust..... lb.	08 1/2 - 09	09 1/2 - 10
Zinc oxide, XX..... lb.	03 1/2 - 03 1/2	04 - 05
Zinc sulphate..... lb.		

## Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude..... lb.	\$1 15 - \$1 25
Alpha-naphthol, refined..... lb.	1 45 - 1 50
Alpha-naphthylamine..... lb.	38 - 40
Aniline oil, drums extra..... lb.	20 - 26
Aniline salts..... lb.	26 - 29
Anthracene, 80% in drums (100 lb.)..... lb.	75 - 1 00
Benzaldehyde U.S.P..... lb.	1 00 - 1 50
Benzidine, base..... lb.	90 - 1 00
Benzidine sulphate..... lb.	75 - 80
Benzoic acid, U.S.P..... lb.	65 - 70
Benzoate of soda, U.S.P..... lb.	65 - 70
Benzene, pure, water-white, in drums (100 gal.)..... gal.	30 - 35
Benzene, 90% in drums (100 gal.)..... gal.	28 - 32
Benzyl chloride, 95-97% refined..... lb.	28 - 30
Benzyl chloride, tech..... lb.	25 - 27
Beta-naphthol benzene..... lb.	3 50 - 4 00
Beta-naphthol, sublimed..... lb.	70 - 75
Beta-naphthol, tech..... lb.	33 - 45
Beta-naphthylamine, sublimed..... lb.	2 25 - 2 40
Cresol, U. S. P., in drums (100 lb.)..... lb.	16 - 18
Ortho-cresol, in drums (100 lb.)..... lb.	23 - 25
Cresylic acid, 97-99%, straw color, in drums..... gal.	90 - 95
Cresylic acid, 75-97%, dark, in drums..... gal.	85 - 90
Cresylic acid, 50% first quality, drums..... gal.	55 - 60
Dichlorobenzene..... lb.	06 - 09
Diethylaniline..... lb.	1 25 - 1 30
Dimethylaniline..... lb.	50 - 60
Dinitrobenzene..... lb.	30 - 32
Dinitrochlorobenzene..... lb.	25 - 30
Dinitronaphthalene..... lb.	33 - 35
Dinitrophenol..... lb.	40 - 45
Dinitrotoluene..... lb.	25 - 27
Dip oil, 25% tar acids, ear lots, in drums..... gal.	38 - 40
Diphenylamine..... lb.	60 - 70
H-acid..... lb.	1 30 - 1 50
Meta-phenylenediamine..... lb.	1 20 - 1 25
Monochlorobenzene..... lb.	14 - 16
Monothylaniline..... lb.	1 90 - 2 00
Naphthalene crushed, in bbls. (250 lb.)..... lb.	08 - 08 1/2
Naphthalene, flake..... lb.	09 1/2 - 10 1/2
Naphthalene, balls..... lb.	70 - 75
Naphthionic acid, crude..... lb.	12 - 15
Nitrobenzene..... lb.	30 - 35
Nitro-naphthalene..... lb.	16 - 18
Nitro-toluene..... lb.	3 20 - 3 75
Ortho-amidophenol..... lb.	15 - 20
Ortho-dichlor-benzene..... lb.	75 - 80
Ortho-nitro-phenol..... lb.	17 - 20
Ortho-nitro-toluene..... lb.	25 - 30
Ortho-toluidine..... lb.	1 90 - 2 00
Para-amidophenol, base..... lb.	2 10 - 2 20
Para-amidophenol, HCl..... lb.	

Para-dichlorobenzene..... lb.	15 - 20
Paranitroaniline..... lb.	85 - 90
Para-nitrotoluene..... lb.	90 - 1 05
Para-phenylenediamine..... lb.	1 90 - 2 00
Para-toluidine..... lb.	1 25 - 1 60
Phthalic anhydride..... lb.	50 - 60
Phenol, U. S. P., drums (dest.), (240 lb.)..... lb.	12 - 14
Pyridine..... gal.	2 00 - 3 50
Resorcinol, technical..... lb.	1 85 - 2 00
Resorcinol, pure..... lb.	2 30 - 2 50
Salicylic acid, tech., in bbls. (110 lb.)..... lb.	22 - 23
Salicylic acid, U. S. P..... lb.	25 - 27
Salol..... lb.	85 - 95
Solvent naphtha, water-white, in drums, 100 gal..... gal.	28 - 32
Solvent naphtha, crude, heavy, in drums, 100 gal..... gal.	16 - 18
Sulphanilic acid, crude..... lb.	30 - 35
Tolidine..... lb.	1 35 - 1 45
Toluidine, mixed..... lb.	40 - 45
Toluene, in tank cars..... gal.	28 - 32
Toluene, in drums..... gal.	30 - 35
Xyldines, drums, 100 gal..... lb.	40 - 45
Xylene, pure, in drums..... gal.	42 - 45
Xylene, pure, in tank cars..... gal.	45 - 45
Xylene, commercial, in drums, 100 gal..... gal.	33 - 35
Xylene, commercial, in tank cars..... gal.	30 - 35

## Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark..... lb.	\$0 24 - \$0 26
Beeswax, refined, light..... lb.	27 - 28
Beeswax, white pure..... lb.	40 - 45
Carnauba, Florida..... lb.	68 - 70
Carnauba, No. 2, North Country..... lb.	30 - 32
Carnauba, No. 3, North Country..... lb.	18 - 19
Japan..... lb.	19 1/2 - 20
Montan, crude..... lb.	07 - 08
Paraffine waxes, crude match wax (white) 105-110 m.p..... lb.	03 1/2 - 03 1/2
Paraffine waxes, crude, seal 124-126 m.p..... lb.	02 1/2 - 03
Paraffine waxes, refined, 118-120 m.p..... lb.	04 - 04 1/2
Paraffine waxes, refined, 125 m.p..... lb.	04 1/2 - 05
Paraffine waxes, refined, 128-130 m.p..... lb.	05 - 06
Paraffine waxes, refined, 133-135 m.p..... lb.	06 - 06 1/2
Paraffine waxes, refined, 135-137 m.p..... lb.	06 1/2 - 06 1/2
Stearic acid, single pressed..... lb.	11 - 11 1/2
Stearic acid, double pressed..... lb.	11 1/2 - 12
Stearic acid, triple pressed..... lb.	12 - 12 1/2

## Flotation Oils

All prices are f.o.b. New York unless otherwise stated, and are based on earload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp.gr. 0.930-0.940..... gal.	\$1 70
Pine oil, pure, dest. dist..... gal.	1 60
Pine tar oil, ref., sp.gr. 1.025-1.035..... gal.	.48
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla..... gal.	.35
Pine tar oil, double ref., sp.gr. 0.965-0.990..... gal.	.75
Pine tar, ref., thin, sp.gr. 1.080-1.060..... gal.	.36
Turpentine, crude, sp.gr. 0.900-0.970..... gal.	1.20
Hardwood oil, f.o.b. Mich., sp.gr. 0.960-0.990..... gal.	.37
Pinewood creosote, ref..... gal.	.55

## Naval Stores

The following prices are f.o.b. New York for earload lots.

Rosin B-D, bbl..... 280 lb.	\$5 50
Rosin E-I..... 280 lb.	5 75
Rosin K-N..... 280 lb.	6 00
Rosin W-G-W-W..... 280 lb.	6 25
Wood rosin, bbl..... 280 lb.	6 75
Spirits of turpentine..... gal.	57
Wood turpentine, steam dist..... gal.	56
Wood turpentine, dest. dist..... gal.	55
Pine tar pitch, bbl..... 200 lb.	7 00
Tar, kiln burned, bbl. (500 lb.)..... bbl.	14 50
Retort tar, bbl..... 500 lb.	15 00
Rosin oil, first run..... gal.	45
Rosin oil, second run..... gal.	48
Rosin oil, third run..... gal.	60

## Solvents

73-76 deg., steel bbls. (85 lb.)..... gal.	\$0 41
70-72 deg., steel bbls. (85 lb.)..... gal.	.39
68-70 deg., steel bbls. (85 lb.)..... gal.	.38
V. M. and P. naphtha, steel bbls. (85 lb.)..... gal.	.30

## Crude Rubber

Para-Upriver fine..... lb.	\$0 17 - \$0 18
Upriver coarse..... lb.	13 - 14
Upriver cauchoo ball..... lb.	14 - 14 1/2
Plantation—First latex crepe..... lb.	19
Ribbed smoked sheets..... lb.	17 1/2
Brown crepe, thin, clean..... lb.	18
Amber crepe No. 1..... lb.	20

## Oils

## VEGETABLE

The following prices are f.o.b. New York for earload lots.

Castor oil, No. 3, in bbls..... lb.	\$0 08 - \$0 08 1/2
Castor oil, AA, in bbls..... lb.	09 1/2 - 10
China wood oil, in bbls. (f.o.b. Pac. coast)..... lb.	07 1/2 - 08
Cocaoat oil, Ceylon grade, in bbls..... lb.	09 1/2 - 09 1/2
Cocaoat oil, Cochon grade, in bbls..... lb.	09 1/2 - 10
Corn oil, crude, in bbls..... lb.	08 - 08 1/2
Cottonseed oil, crude (f. o. b. mill)..... lb.	04 1/2 - 05
Cottonseed oil, summer yellow..... lb.	06 1/2 - 07
Cottonseed oil, winter yellow..... lb.	07 - 07 1/2
Linseed oil, raw, ear lots (domestic)..... gal.	65
Linseed oil, raw, tank cars (domestic)..... gal.	58
Linseed oil, in 5-bbl lots (domestic)..... gal.	68 - 70

Olive oil, commercial.....	gal.	\$2.00	— \$2.50
Palm, Lagos.....	lb.	.07	— .07½
Palm, Niger.....	lb.	.06½	— .07
Peanut oil, crude, tank cars (f.o.b. mill).....	lb.	.05½	— .05½
Peanut oil, refined, in bbls.....	lb.	.11	— .11½
Rapeseed oil, refined in bbls.....	gal.	1.05	— 1.10
Rapeseed oil, blown, in bbls.....	gal.	1.15	— 1.20
Soya bean oil (Manchurian), in bbls, N. Y.....	lb.	.07	— .07½
Soya bean oil, tank cars, f.o.b., Pacific coast.....	lb.	.04½	— .05

## FISH

Light pressed menhaden.....	gal.	\$0.45	— \$0.47
Yellow bleached menhaden.....	gal.	.47	— .49
White bleached menhaden.....	gal.	.49	— .51
Blown menhaden.....	gal.	.84	— .86

## Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.....	net ton	\$24.00	— 30.00
Barytes, ground, off color, f.o.b. Kings Creek.....	net ton	22.00	— 26.00
Barytes, crude, 88% (a 94% ba., Kings Creek.....	net ton	10.00	— 11.00
Barytes, floated, f.o.b. St. Louis.....	net ton	26.50	— 28.00
Barytes, crude, first grade, Missouri.....	net ton	10.00	— 11.00
Blanc fixe, dry.....	lb.	.05	— .05½
Blanc fixe, pulp.....	net ton	50.00	— 60.00
Casein.....	lb.	.14	— .16
Chalk, domestic, extra light.....	lb.	.05	— .05½
Chalk, domestic, light.....	lb.	.04½	— .05
Chalk, domestic, heavy.....	lb.	.04	— .05
Chalk, English, extra light.....	lb.	.05	— .07
Chalk, English, light.....	lb.	.05	— .06
Chalk, English, dense.....	lb.	.04½	— .05
China clay (kaolin) crude, f.o.b. mines, Georgia.....	net ton	8.00	— 10.00
China clay (kaolin) washed, f.o.b. Georgia.....	net ton	12.00	— 15.00
China clay (kaolin) powdered, f.o.b. Georgia.....	net ton	18.00	— 22.00
China clay (kaolin) crude f.o.b. Virginia points.....	net ton	8.00	— 12.00
China clay (kaolin) ground, f.o.b. Virginia points.....	net ton	15.00	— 40.00
China clay (kaolin), imported, lump.....	net ton	23.00	— 25.00
China clay (kaolin), imported, powdered.....	net ton	30.00	— 35.00
Feldspar, crude, f.o.b. Maryland and North Carolina points.....	gross ton	8.00	— 14.00
Feldspar, crude, f.o.b. Maine.....	net ton	7.50	— 10.00
Feldspar, ground, f.o.b. Maine.....	net ton	21.00	— 23.00
Feldspar, ground, f.o.b. North Carolina.....	net ton	17.00	— 21.00
Feldspar, ground, f.o.b. N. Y. State.....	net ton	17.00	— 21.00
Feldspar, ground, f.o.b. Baltimore.....	net ton	27.00	— 30.00
Fullers earth, f.o.b. Mires.....	net ton	16.00	— 17.00
Fullers earth, granular, f.o.b. Fla.....	net ton	25.00	— 28.00
Fullers earth, powdered, f.o.b. Fla.....	net ton	18.00	— 20.00
Fullers earth, imported, powdered.....	net ton	30.00	— 35.00
Graphite, Ceylon lump, first quality.....	lb.	.08	— .09
Graphite, Ceylon chip.....	lb.	.07	— .08
Graphite, higher lubricating grades.....	lb.	.11	— .40
Pumice stone, imported, lump.....	lb.	.04	— .50
Pumice stone, domestic lump.....	lb.	.05	— .05½
Pumice stone, ground.....	lb.	.06	— .07
Quartz (acid tower) first to head, f.o.b. Baltimore.....	net ton	—	10.00
Quartz (acid tower) 1½ to 2 in., f.o.b. Baltimore.....	net ton	—	14.00
Quartz (acid tower) rice, f.o.b. Baltimore.....	net ton	—	17.00
Quartz, lump, f.o.b. North Carolina.....	net ton	5.00	— 7.50
Shellac, orange fine.....	lb.	.57	— .60
Shellac, orange superfine.....	lb.	.60	— .65
Shellac, A. C. garnet.....	lb.	.45	— .50
Shellac, T. N.....	lb.	.45	— .50
Soapstone.....	ton	12.00	— 15.00
Sodium chloride.....	long ton	14.00	— 15.00
Talc, paper-making grades, f.o.b. Vermont.....	ton	12.00	— 22.00
Talc, roofing grades, f.o.b. Vermont.....	ton	9.50	— 15.00
Talc, rubber grades, f.o.b. Vermont.....	ton	12.00	— 18.00
Talc, powdered, Southern, f.o.b. cars.....	ton	12.00	— 15.00
Talc, imported.....	ton	40.00	— 50.00
Talc, California talcum powder grade.....	ton	20.00	— 40.00

## Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh.....	1,000	160	
Chrome brick, f.o.b. Eastern shipping points.....	net ton	80-100	
Chrome cement, 40-45% Cr <sub>2</sub> O <sub>3</sub> .....	net ton	45-50	
Chrome cement, 40-45% Cr <sub>2</sub> O <sub>3</sub> , sacks, in car lots, f.o.b. Eastern shipping points.....	net ton	—	55
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	55-60	
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	45-50	
Magnesite brick, 9-in. straight.....	net ton	100	
Magnesite brick, 9-in. arches, wedges and keys.....	net ton	105	
Magnesite brick, soaps and splits.....	net ton	120	
Silica brick, 9-in. sizes, f.o.b. Chicago district.....	1,000	65-70	
Silica brick, 9-in. sizes, f.o.b. Birmingham district.....	1,000	56-61	
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.....	1,000	50-60	

## Ferro-Alloys

All f.o.b. Works

Ferr-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.....	net ton	\$200.00	— \$225.00
Ferrochrome per lb. of Cr. contained, 6-8% carbon, carlots.....	lb.	.15	— .16
Ferrochrome per lb. of Cr. contained, 4-6% carbon, carlots.....	lb.	.15	— .16
Ferrromanganese, 76-80% Mn, domestic.....	gross ton	90.00	— 95.00
Ferrromanganese, 76-80% Mn, English.....	gross ton	90.00	— 95.00
Spiegelisen, 18-22% Mn.....	gross ton	30.00	— 35.00
Ferrromolybdenum, 50-60% Mo, per lb. of Mo.....	lb.	2.50	— 3.00
Ferro-silicon, 10-15%.....	gross ton	50.00	— 55.00
Ferro-silicon, 50%.....	gross ton	85.00	— 90.00
Ferro-silicon, 75%.....	gross ton	145.00	— 150.00
Ferrotungsten, 70-80% per lb. of contained W.....	lb.	6.00	— 5.50
Ferrovanadium, 35-50% of V, per lb. of U content.....	lb.	5.00	— 6.50
Ferrovanadium, 30-40% per lb. of contained V.....	lb.	5.00	— 6.50

## Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content.....	gross ton	\$10.00	— \$11.00
Chrome ore, Calif. concentrates, 50% min. Cr <sub>2</sub> O <sub>3</sub> .....	unit	.45	— .50
Chrome ore, 50% Cr <sub>2</sub> O <sub>3</sub> , f.o.b. Atlantic seaboard.....	unit	.45	— .50
Coke, foundry, f.o.b. ovens.....	net ton	5.50	— 6.00
Coke, furnace, f.o.b. ovens.....	net ton	4.50	— 5.00
Coke, petroleum, refinery, Atlantic seaboard.....	net ton	15.00	— 16.00
Fluorspar, lump, f.o.b. Heathden, New Mexico.....	net ton	17.50	— 18.00
Fluorspar, standard, domestic washed gravel.....	net ton	22.50	— 25.00
Kentucky and Illinois mines.....	lb.	.01½	— .01½
Ilmenite, 52% TiO <sub>2</sub> , per lb. ore.....	lb.	.35	— .40
Manganese ore, 50% Mn, c.i.f. Atlantic seaport.....	unit	60.00	— 65.00
Manganese ore, chemical (MnO <sub>2</sub> ).....	gross ton	60.00	— 65.00
Molybdenite, 85% MoS <sub>2</sub> , per lb. of MoS <sub>2</sub> , N. Y.....	lb.	.55	— .60
Monazite, per unit of ThO <sub>2</sub> , c.i.f. Atlantic seaport.....	unit	30.00	— 35.00
Pyrites, Spanish, fines, c.i.f. Atlantic seaport.....	unit	.16	— .18
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport.....	unit	.16	— .18
Pyrites, domestic, fines, f.o.b. mines, Ga.....	unit	.12	— .14
Rutile, 95% TiO <sub>2</sub> , per lb. ore.....	lb.	.15	— .16
Tungsten, scheelite, 60% WO <sub>3</sub> and over, per unit of WO <sub>3</sub> (nominal).....	unit	3.00	— 3.25
Tungsten, Wolframite, 60% WO <sub>3</sub> and over, per unit of WO <sub>3</sub> , N. Y. C.....	unit	3.00	— 3.25
Uranium ore (carnotite) per lb. of U <sub>3</sub> O <sub>8</sub> .....	lb.	1.50	— 2.50
Uranium oxide, 96% per lb. contained U <sub>3</sub> O <sub>8</sub> .....	lb.	2.25	— 2.50
Vanadium pentoxide, 99%.....	lb.	12.00	— 14.00
Vanadium ore, per lb. of V <sub>2</sub> O <sub>5</sub> contained.....	lb.	1.50	— 1.60
Zircon, washed, iron free.....	lb.	.03	— .04

## Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic.....	12.00
Aluminum, 98 to 99 per cent.....	28 3/4 @ 28 5/8
Antimony, wholesale lots, Chinese and Japanese.....	5 1/2 @ 5 1/4
Nickel, ordinary (ingot).....	41.00
Nickel, electrolytic.....	44.00
Monel metal, spot and blocks.....	35
Monel metal ingots.....	38
Monel metal, sheet bars.....	40
Tin, 5-ton lots.....	28.50
Lead, New York, spot.....	4.00 @ 4.20
Lead, E. St. Louis, spot.....	4.00
Zinc, spot, New York.....	7.00
Zinc, spot, E. St. Louis.....	4.70

## OTHER METALS

Silver (commercial).....	oz.	\$0.56½
Cadmium.....	lb.	1.10
Bismuth (500 lb. lots).....	lb.	1.50 @ 1.65
Cobalt.....	lb.	4.50
Magnesium (f.o.b. Philadelphia).....	lb.	1.25
Platinum.....	oz.	72.00-75.00
Iridium.....	oz.	250.00 @ 300.00
Palladium.....	oz.	65.00 @ 70.00
Mercury.....	75 lb.	46.00

## FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled.....	20.50
Copper bottoms.....	28.00
Copper rods.....	18.75
High brass wire.....	18.25
High brass rods.....	15.25
Low brass wire.....	20.25
Low brass rods.....	20.25
Brazed brass tubing.....	29.50
Brazed bronze tubing.....	34.25
Seamless copper tubing.....	22.00
Seamless high brass tubing.....	21.00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York		Cleveland	Chicago
	Current	One Year Ago	Current	One Year Ago
Copper, heavy and crucible.....	8.50 @ 9.00	16.50	10.00	10.50
Copper, heavy and wire.....	8.00 @ 8.25	16.50	9.50	9.50
Copper, light and bottoms.....	7.00 @ 7.50	14.50	9.00	8.50
Lead, heavy.....	3.00 @ 3.50	7.25	4.00	4.00
Lead, tea.....	2.00 @ 2.12½	5.25	3.00	3.00
Brass, heavy.....	4.25 @ 4.50	9.50	7.00	10.00
Brass, light.....	3.00 @ 3.25	8.00	5.00	5.50
No. 1 yellow brass turnings.....	4.00 @ 4.25	9.50	5.50	6.00
Zinc.....	2.00 @ 2.50	5.00	3.00	3.50

## Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ½ in. and larger, and plates ½ in. and heavier, from jobbers' warehouses in the cities named:

	New York		Cleveland		Chicago	
	*Current	One Month Ago	*Current	One Year Ago	*Current	One Year Ago
Structural shapes.....	\$3.60	\$3.80	\$3.47	\$3.58	\$3.58	\$3.47
Soft steel bars.....	3.80	3.70	3.52	3.34	3.27	3.48
Soft steel bar shapes.....	3.80	3.70	3.52	3.48	3.27	3.48
Soft steel bands.....	4.20	4.65	4.22	6.25		
Plates, ½ to 1 in. thick.....	3.80	4.00	3.67	3.78	3.57	3.78

\*Add 10c per 100 lb. for trucking to Jersey City and 15c for delivery in New York and Brooklyn



# Industrial

Financial, Construction and Manufacturers' News

## Construction and Operation

### California

**GOLDEN**—The Colorado Feldspar, Flint & Mica Co., Denver, Col., has preliminary plans under way for the construction of a new plant at Golden, to comprise a complete crushing and grinding mill.

### Connecticut

**BRIDGEPORT**—The American Tube & Stamping Co., Stratford Ave., has filed plans for the erection of a new 2-story laboratory building, 30 x 40 ft. It will be used for chemical, physical and other experimental work, divided into seven departments.

### Georgia

**SAVANNAH**—The Atlantic Turpentine & Pine Tar Co., Central Junction, near Savannah, is planning for the rebuilding of its plant recently destroyed by fire. The loss is estimated at \$150,000, instead of \$75,000, as previously announced. D. S. Owen is manager.

### Idaho

**WEISER**—The Idaho Clay Products Co. is planning for the early erection of its proposed new local branch plant, to be located at clay properties near the city.

### Indiana

**HARTFORD CITY**—The Fort Wayne Corrugated Paper Co. is making a number of improvements in its local plant during a curtailment period, and plans for the resumption of operations at an early date.

**WINAMAC**—The Winamac Cement Product & Construction Co. has been organized to take over the cement tile manufacturing plant of the Winamac Tile Co. The new company is said to be planning for a number of improvements in the plant. It is headed by Christopher Hanson, George and John Kenzick.

**SUMMITVILLE**—The Crystal Glass Co. has awarded a contract to the L. J. Drummond Co., Elwood, Ind., for extensions and improvements in its plant. A number of new gas producers, tanks and other equipment will be installed.

### Kentucky

**LOUISVILLE**—The Magic Soap Co., recently organized, has acquired the property of the Magic Soap Products Co. at a receiver's sale for a consideration of \$160,000. The new company will continue the operation of the plant and is said to be planning for a number of improvements. M. O. Curd is president and L. L. Daugherty treasurer.

### Louisiana

**SHREVEPORT**—The United States Window Glass Co., Morgantown, W. Va., will increase the size of its proposed new plant at Jewella, near Shreveport, with total investment of over \$2,000,000 instead of about \$1,000,000 as previously arranged. Plans are under way for the plant and it is expected to inaugurate operations at an early date. Walter A. Jones is president.

**NEW IBERIA**—The Charles Boldt Pulp Co. has awarded a contract to the MacFarlane Construction Co., Cincinnati, Ohio, for extensions in its plant to cost about \$10,000.

### Maryland

**FAIRFIELD**—The Prudential Oil Co. has acquired about 30 acres of property at Fairfield, in the vicinity of its present works, known as the Bowles property, for the erection of a number of extensions. Plans for the work are under way.

**BALTIMORE**—The United States Industrial Chemical Co., Curtis Bay, is completing plans for the proposed extension to its plant at Stonehouse Cove, consisting of a building 60 x 180 ft.

### Massachusetts

**HOLYOKE**—The Paper City Mfg. Co., Rackliffe Bldg., has acquired the building of the Ferguson Laundry Co. at a public sale, and will utilize the structure for proposed extensions. It was secured for a consideration said to be \$16,000.

### New Jersey

**NEWARK**—The Franklin Baker Oil Co., Doremus Ave., is said to be planning for the early rebuilding of the portion of its plant, destroyed by fire March 10, with loss estimated at about \$100,000. The company specializes in the manufacture of coconut oils.

**TRENTON**—The American Rotex Mfg. Co., Cleveland, O., manufacturer of imitation leather products, has acquired the plant of the Trenton Lamp, Brass & Copper Works, New York Ave. and Mulberry St., more recently occupied by the Cosmic Chemical Co., for a consideration said to be about \$100,000. The plant consists of a group of six large buildings with power plant, and the different structures will be remodeled at a cost of about \$30,000 to accommodate the new industry. Machinery and equipment estimated to cost about \$100,000 will be ordered and installed at an early date. Offices will be established at the plant site at once. A. M. Mander is president; P. F. Wills is representative of the company in charge.

**CLAYVILLE**—The L. G. Nester Co., recently incorporated with a capital of \$50,000 to manufacture glassware, has plans under way for its proposed new plant on local site. Lyman G. Nester is head.

**TRENTON**—Fire, March 16, destroyed a portion of the plant of the Ewing Rubber Co., Homan and Hilton Aves., with loss estimated at about \$15,000. It is said that the plant will be rebuilt. George H. Royle is head.

**NEWARK**—The Celluloid Co., 290 Ferry St., will use a considerable portion of the proceeds of its recent capital increase of \$4,000,000 for plant extensions and improvements. During the year just past the company expended a total of \$1,300,000 for work of this character and it is proposed to continue this expansion program. Marshall C. Lefferts is president.

**CAMDEN**—The Russell Products Co., Sixth and Jackson Sts., manufacturer of paper specialties, is arranging for the rebuilding of the portion of its plant recently destroyed by fire with loss of about \$15,000.

**JERSEY CITY**—James H. Rhodes & Co., South Albany Ave., Chicago, Ill., manufacturer of industrial chemicals, has purchased the 2-story factory, 100 x 200 ft., at 34-40 Liberty St., for use as a branch works. The structure heretofore has been held by the Foot Mfg. Co., manufacturer of polishing buffs, felts, etc.

### New York

**BUFFALO**—The Dunlop Rubber Co., River Rd., is planning to inaugurate operations at its new local plant for the manufacture of tires and other rubber goods on April 15, giving employment to about 1,000 operatives. This number will be increased until the working force totals about 5,000 persons before the close of the year. The plant when entirely complete will represent an investment of about \$20,000,000.

**MALONE**—The Northern Process Co. has awarded a contract to Henry I. Jones, Grove St., for the erection of a new 2-story and basement plant, 35 x 140 ft., to cost about \$60,000, forming an addition to its present works.

### North Carolina

**CHARLOTTE**—The American Progressive Sales Co., Asheville, N. C., is planning for the erection of a plant at Charlotte for the manufacture of cement and clay building products. S. F. Roberts is manager.

**GREENSBORO**—The Armour Fertilizer Works, Chicago, Ill., is planning for the early operation of its new acid works now nearing completion, representing a cost of about \$250,000. The plant will be operated

for the production of sulphuric acid for use at the company's fertilizer works at this same place.

### Ohio

**DEFIANCE**—The Farmers' Sugar Co. is having plans prepared for the construction of a new sugar mill on local site, to consist of a number of 1-, 2- and 3-story buildings, estimated to cost about \$1,000,000 with machinery. A. H. Smith, 215 Nasby Bldg., Toledo, O., is engineer. Charles H. Allen is president.

**WILLIARD**—The Pioneer Rubber Co. has completed plans for the erection of the proposed new 2-story addition to its plant, 63 x 160 ft., and will soon call for bids. It is estimated to cost about \$50,000. A number of homes for employees will also be constructed. Granville E. Scott, Norwalk, Ohio, is architect. B. O. Smith is president.

### Oklahoma

**MUSKOGEE**—The Muskogee Cotton Oil Co., 724 Mill St., is planning for the rebuilding of the portion of its plant recently destroyed by fire with loss estimated at about \$15,000. George H. Walker is president.

**TULSA**—The Phanotax Chemical Co., recently removed to Tulsa from Memphis, Tenn., has acquired a half block of property on Fourth St., between Frankfort and Elgin Sts., 150 x 300 ft., for the erection of a new 7-story and basement building, a large portion of which will be given over to chemical and chemical byproduct manufacture. The new plant is estimated to cost about \$400,000 with equipment.

**LAWTON**—The Damascus Refining Co., Cleveland, O., is perfecting plans for the erection of its proposed new plant at Lawton for the manufacture of waxes to be used for lubricating oil production. W. G. Black is president.

### Ontario

**TRENTON**—The Chemical Products Co. is having plans prepared for the erection of a new plant for the manufacture of fertilizer products, to consist of three buildings, each 1 story, 80 x 220 ft., 60 x 120 ft. and 50 x 50 ft., estimated to cost about \$500,000 with machinery. The Austin Co., 16122 Euclid Ave., Cleveland, O., is in charge. A. H. C. Hartman is head.

### Oregon

**PORTLAND**—The Portland Vegetable Oil Mills has inaugurated preliminary work on its proposed new local plant, to be located on a portion of the site previously used by the Foundation Co. as shipyard property. Actual construction of the new mills will be started early in April. The plant is estimated to cost about \$450,000 with machinery.

**OREGON CITY**—T. B. McBain and associates, Oregon City, are perfecting plans for the construction of a new local paper mill.

### Pennsylvania

**PHILADELPHIA**—The Rinold Brothers Paint Works, Inc., has taken title to the 2-story brick factory on Grove St., near Wharton St., 50 x 314 ft., for a local plant. The site was secured for a consideration said to be \$43,000.

**KANE**—The Interstate Glass Co., Bradford, Pa., has plans under way for extensions and improvements at its plant at Kane, to cost about \$70,000. H. J. Walters is head.

### Texas

**BRECKENRIDGE**—The Shamrock Oil Corp. has plans under way for the erection of the initial unit of its proposed new casinghead gasoline plant. Construction will be inaugurated at an early date.

### West Virginia

**HUNTINGTON**—The West Virginia Glass Mfg. Co. is planning for the erection of a number of additions to its plant to double, approximately, the present output. New automatic blowing machines and auxiliary operating equipment will be installed. The plant specializes in the manufacture of glass jars and has a present capacity of from two to three cars a day. The expansion is estimated to cost about \$75,000. B. G. Landau is general manager.

### Wisconsin

**MILWAUKEE**—The building occupied by the Frazer Paper Co., National Belting & Salvage Co. and kindred industrial interests was destroyed by fire March 17, with total loss of about \$130,000, distributed among the companies.

## New Companies

THE WEST CHEMICAL CO., 313 South Clinton St., Chicago, Ill., has been incorporated with a capital of \$30,000 to manufacture chemicals and chemical byproducts. The incorporators are A. B. Rosenfeld, Abraham Jacobson and Abraham M. Gordon.

THE WINOIL SUPPLY CO., Passaic, N. J., has been incorporated with a capital of \$100,000 to manufacture refined oils and affiliated products. The incorporators are John Hanley, Thomas E. Duffy and Peter J. Wynne, 185 Jefferson St.

THE IDOLA CHEMICAL MFG. CO., New York, has been incorporated with a capital of \$100,000 to manufacture chemicals and chemical byproducts. The incorporators are T. J. O'Hanlon, J. Reusch and C. Mas-singill, 152 Madison Ave.

LEVEISEUR, HAROTH & CO., INC., Boston, Mass., has been incorporated with a capital of \$100,000 to manufacture leather products; the company will operate a tannery. The incorporators are Frederick J. Levisaur, A. W. Hull and Alfred W. Haroth, 5 Stratford Rd., Melrose, Mass.

THE CERAMIC PRODUCTS CO., 175 West Jackson Blvd., Chicago, Ill., has been incorporated with a capital of 75,000 to manufacture pottery and other fine ceramics. The incorporators are William C. Danna, Walter W. Weiss and E. S. Radcliffe.

THE AMERICAN LABORATORY PRODUCTS CO., Cleveland, O., has been incorporated with a capital of \$2,000,000 under Delaware laws, to manufacture chemicals and chemical byproducts. The incorporators are H. Linsdale Smith, W. C. Husted and G. S. Patterson, Cleveland.

THE RAVENSWOOD PORCELAIN CO., Ravenswood, W. Va., has been incorporated with a capital of \$50,000, to manufacture porcelain products. The incorporators are Charles W. Turnbull, New Haven, W. Va.; J. H. Camp and J. W. Hall, Ravenswood.

THE HIMMER BROS. CO., INC., 1221 East Monument St., Baltimore, Md., has been incorporated with a capital of \$20,000 to manufacture paper products. The incorporators are John C. and Charles Himmer and John H. Renner.

THE AMPROCO CO., New York, has been incorporated with a capital of \$10,000 to manufacture chemicals and chemical byproducts. The incorporators are S. R. Barrett, and C. F. and L. T. Glendhill, 684 East 19th St., Brooklyn.

THE MARVELLUM CO., Holyoke, Mass., has been incorporated with a capital of \$15,000, to manufacture paper products. The incorporators are R. S. Bracewell, George E. Senseney and Francis C. Heywood, Holyoke.

THE SANITARY CHEMICAL SPECIALTIES CO., 208 North Wells St., Chicago, Ill., has been incorporated with a capital of \$15,000, to manufacture chemicals. The incorporators are Walter H. Shryock and J. W. and Arthur C. Tretow.

THE WESTERN NEW YORK PAPER CO., Rochester, N. Y., has been incorporated with a capital of \$15,000, to manufacture paper specialties. The incorporators are C. H. Mason and G. and J. Doyle, Rochester.

THE HIGH GRADE LARD & COMPOUND CO., INC., 2600 Hafer St., Baltimore, Md., has been incorporated with a capital of \$25,000, to manufacture lards and compounds. The incorporators are Max Baker, Robert Plein and William E. Bragg.

THE TEXTILE LEATHER & METAL PRESERVER CO., Kalamazoo, Mich., has been incorporated with a capital of \$100,000, to manufacture compounds and chemical preservatives for textiles, leather and metal products. The incorporators are Clarence D. Shaffer, and Willard R. Sparks, Kalamazoo; and Elbert W. Sweet, Benton Harbor, Mich.

THE SIGNAL MOUNTAIN PORTLAND CEMENT CO., Atlanta, Ga., has been incorporated with a capital of \$3,000,000, to manufacture cement, lime and affiliated products. The incorporators are R. C. Labiens, St. Angar, Ia.; and Ralph A. Law, Mason City, Ia.

THE CLENSOL CHEMICAL CO., INC., Salem, N. J., has been incorporated with a capital of \$100,000, to manufacture chemicals and chemical byproducts. The incorporators are I. Castelli, Louis O. Bergh and E. E. Cushing, Salem.

THE CALABRA CHEMICAL CO., Boston, Mass., has filed notice of organization to manufacture chemical products. The company is headed by Abraham M. Berman and Harry Chaimken, 8 Crawford St., Roxbury, Mass.

THE MUNN LABORATORIES, 518 Main St., East Orange, N. J., has filed notice of organization to manufacture chemical products. The company is headed by Robert Loder, 60 Walnut St., East Orange.

THE ONTARIO-CORONA OIL CO., Los Angeles, Cal., has been incorporated with a capital of \$5,000,000 to manufacture petroleum products. The incorporators are F. A. Welshans, Alhambra, Cal.; L. R. Kennedy and C. E. White, Ontario, Cal.; and P. W. Lacy, Los Angeles.

THE VICTOR INK CO., Jersey City, N. J., has been incorporated with a capital of \$350,000, to manufacture inks. The incorporators are E. Burke Tinnerty, G. M. Jones and Isador Halprin, Jersey City.

THE DOOLEY MFG. CO., Philmont (Columbia Co.), N. Y., has been incorporated with a capital of \$50,000, to manufacture glue, chemical products, etc. The incorporators are J. E. Clune, E. L. and C. E. Dooley, Philmont.

THE R. R. GLASS WORKS, INC., Providence, R. I., has been incorporated with a capital of \$50,000, to manufacture glass products. The incorporators are Hiram G. Hall, 372 Benefit St.; Peter Perrotta and Ralph Kakusian.

THE PLANTERS' LIME, PHOSPHATE & FERTILIZER CO., Penters Bluff, Ark., has been incorporated with a capital of \$1,500,000, to manufacture fertilizers, lime and affiliated products. The incorporators are J. R. Alexander, Scotts, Ark.; R. R. Ramey, Kensett, Ark.; and J. W. Williamson, Batesville, Ark.

THE ALL-KLEAN MFG. CO., New York, has been incorporated with a capital of \$10,000, to manufacture valve grinding compounds, chemical specialties, etc. The incorporators are C. and C. Cunningham, Jr., and R. Lee, 111 Young St., Brooklyn.

THE TUDOR PRODUCTS CO., New York, has been incorporated with a capital of \$55,000, to manufacture chemicals and chemical byproducts. The incorporators are E. Levy, J. J. Fischer and R. E. Tinsley, 299 Bway.

THE ELK HILLS CRUDE OIL CO., Los Angeles, Cal., has been incorporated with a capital of \$350,000, to manufacture petroleum products. The incorporators are William O. Maxwell, Fred V. Gordon and R. E. Kline, all of Los Angeles. Andrews Toland & Andrews, 916-24 Union Oil Bldg., head the company.

THE CLIMAX SPECIALTIES CO., Jersey City, N. J., has been incorporated with a capital of \$25,000, to manufacture chemicals and chemical byproducts. The incorporators are W. B. Madden, Fred Bebbler and Samuel H. Neve, 1035 Summit Ave.

THE AJAX RUBBER CO., Dallas, Tex., has been incorporated with a capital of \$25,000, to manufacture rubber products. The incorporators are L. D. Ormsby, F. C. Burnett and W. J. Jackson, Dallas.

THE GENESSEE POTTERY CO., Chittenango (Madison Co.), N. Y., has been incorporated with a capital of \$5,000, to manufacture pottery and other ceramic products. The incorporators are A. W. Surles, J. H. Thompson and J. M. Moir, Marcellus, N. Y.

THE DIRECT RUBBER CO., 46 Paterson St., New Brunswick, N. J., has been incorporated with a capital of \$500,000, to manufacture rubber goods. The incorporators are Samuel C. Clark, Willett S. Chinery and John J. Moriarty, New Brunswick.

THE KENNEBEC PULPWOOD CO., Augusta Me., has been incorporated with a capital of \$100,000, to manufacture pulpwood and paper products. Blaine S. Viles is president and W. R. Pattangall treasurer.

THE APEX OIL CO., Los Angeles, Cal., has been incorporated with a capital of \$1,000,000, to manufacture petroleum products. The incorporators are Arthur C. Gage, Leslie C. Monks and M. L. Jenks, Los Angeles. Adams, Adams & Blinford, 716 Van Nuys Bldg., represent the company.

THE BOYSTON PAPER CO., Boston, Mass., has been incorporated with a capital of \$500,000, to manufacture paper products. The incorporators are T. Mercer Atkinson, M. MacGill, Cambridge, Mass.; and Ralph F. Alvord, Auburndale, Mass.

THE HUDSON VALLEY OIL CO., Kingston, N. Y., has been incorporated with a capital of \$30,000, to manufacture petroleum products. The incorporators are C. Wilson, A. R. Newcomb and W. G. Maus, Kingston.

THE NORTHERN REFRACTORIES CO., Ridgway, Pa., has been organized to manufacture firebrick, furnace linings and other refractory products. The company is headed by Ives J. Harvey, Bellefonte, Pa.; M. P. Shanley, Ridgway; and E. J. Burke, Rochester, N. Y.

## Capital Increases, Etc.

THE ROESCH ENAMEL RANGE CO., Belleville, Ill., has filed notice of increase in capital from \$15,000 to \$75,000.

THE FALL CITIES HYDRAULIC BRICK CO., Jeffersonville, Ind., has filed notice of increase in capital from \$50,000 to \$100,000.

THE ACME SANITARY POTTERY CO., May St., Trenton, N. J., manufacturer of sanitary earthenware, has filed notice of increase in capital from \$50,000 to \$200,000.

THE ESCANABA PAPER CO., Escanaba, Mich., has filed notice of increase in capital from \$2,800,000 to \$3,000,000.

THE LOCKWAY, STOUCK PAPER CO., Benton Harbor, Mich., has filed notice of increase in capital from \$50,000 to \$100,000.

## Coming Meetings and Events

AMERICAN CHEMICAL SOCIETY will hold its sixty-first meeting at Rochester, N. Y., April 26 to 29. Headquarters will be at the Hotel Rochester.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its spring meeting at Atlantic City April 21 to 23 inclusive. Headquarters will be at the Hotel Chalfonte.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its spring meeting June 20 to 24 at Detroit. Industrial excursions will be made to Ann Arbor, Saginaw, Midland and Bay City.

AMERICAN LEATHER CHEMISTS ASSOCIATION will hold its eighteenth annual meeting at the Hotel Ambassador, Atlantic City, June 9, 10 and 11.

AMERICAN MINING CONGRESS AND NATIONAL EXPOSITION OF MINES AND MINING EQUIPMENT will hold its twenty-fourth annual convention in the Coliseum, Chicago, Oct. 17 to 22.

AMERICAN OIL CHEMISTS' SOCIETY (formerly the Society of Cotton Products Analysts) will hold its twelfth annual meeting in Chicago May 16 to 17. Headquarters will be at the Congress Hotel.

AMERICAN PAPER & PULP ASSOCIATION will hold its annual meeting at the Waldorf-Astoria and Hotel Astor, New York City, April 11 to 15.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS will hold its spring meeting at the Congress Hotel, Chicago, May 23 to 26.

AMERICAN SOCIETY FOR STEEL TREATING will hold its third annual convention and exhibition Sept. 19 to 24 at Indianapolis.

AMERICAN SOCIETY FOR TESTING MATERIALS will hold its 1921 annual meeting in the New Monterey Hotel, Asbury Park, N. J., during the week of June 20.

AMERICAN ZINC INSTITUTE will hold its annual meeting in St. Louis May 9 and 10.

BRITISH IRON AND STEEL INSTITUTE will hold its spring meeting May 5 and 6, at the Institution of Civil Engineers, Great George St., S. W. 1, London, England.

CHAMBER OF COMMERCE OF THE UNITED STATES will hold its ninth annual meeting in Atlantic City April 27, 28 and 29.

HARVARD ALUMNI CHEMISTS' ASSOCIATION will meet Tuesday noon April 26 at Rochester, N. Y., for luncheon.

THE NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (SEVENTH) will be held during the week of Sept. 12, in the Eighth Coast Artillery Armory, New York City.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stetters Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

SOCIETY OF INDUSTRIAL ENGINEERS will hold a meeting in Milwaukee April 27 to 29.

STAMFORD CHEMICAL SOCIETY, Stamford, Conn., holds a meeting in the lecture room of the local high school on the fourth Monday of each month, except June, July, August and September.

TECHNICAL ASSOCIATION OF THE PULP & PAPER INDUSTRY will hold its annual meeting at the Waldorf-Astoria and Hotel Astor, N. Y., April 11 to 14.

The following chemical societies will meet at Rumford Hall, Chemists' Club, New York City, as follows: April 22, Society of Chemical Industry, joint meeting with American Electrochemical Society, Société de Chimie Industrielle and American Chemical Society; May 6, American Chemical Society, Nichols Medal award; May 13, Société de Chimie Industrielle, joint meeting with American Chemical Society, Society of Chemical Industry and American Electrochemical Society; May 20, Society of Chemical Industry; June 10, American Chemical Society.